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JOURNAL OF FORESTRY

OL. XXX JANUARY, 1932 No. 1

e Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it.

EDITORIAL

New York Increases Its Lead in State Forestry

FORESTRY unwittingly joined politics in New York State recently to make strange bedfellows. It happened uring the campaign for the Hewitt re-restation constitutional amendment and sulted in forestry becoming nation-wide ont-page news the morning after the ection, November 3. More exactly, the rominence accorded forestry was the re-ılt of an unnatural fervor for forestry the part of Tammany and an equally nnatural, as well as unexpected, opposi-on on the part of a former governor the state, unnatural because he is now trustee of the state college of forestry. he present Governor, so definitely a be-ever in forestry as to spend his own oney in its practice on his personal estate, thusiastically supported the measure. For veral weeks after the election the me-lliance furnished newspaper editors and ature writers plenty of "copy" and cause r amused speculation as to its signifi-nce. The forestry amendment in itself as a piece of legislation of outstanding erit and of great importance to New York ate and meant an outlay of a huge sum money. It was essentially nonpartisan d as such received the usual limited tention from the people until the tilt be-een the Governor and ex-Governor about o weeks prior to the election and the support of Tammany brought it more definitely to notice. As a pawn in the great game of politics it received the publicity of a major piece, the effect of which upon more favorable sentiment toward forestry in New York and elsewhere was most beneficial. The measure carried with a vote of nearly 3 to 2.

The Hewitt amendment is in the form of a new section, No. 16, added to the already-existing constitutional Article VII. This article provides for the extension and management of the so-called forest preserves and its Section 7 dictates the policy of keeping the forest preserve lands in a wild state and prohibits tree cutting of any kind. The new Section 16, *i.e.*, the Hewitt amendment, extends to areas outside the preserve boundaries the state's plan to acquire, hold, reforest and manage lands for forest purposes, and specifically permits the acquisitions made under its authority to be set up as "production forests" from which in due time the trees may be cut, sold and removed. The new section does not interfere in any way with the state's policy toward the preserves, in fact, it reiterates the mandate that they are to be kept in a wild state. The amendment authorizes appropriation by the legislature, in each

of the eleven calendar years immediately following its adoption, of funds for the acquisition of suitable lands outside the present Adirondack and Catskill state parks, and for their reforestation, protection and management. Beginning with an initial sum of $1,000,000 the annual appropriations are to be stepped up by $200,000 increments to $2,000,000, at which figure they are to continue for five years. For the eleven years the total appropriation is thus $19,000,000, a sum deemed sufficient to acquire and reforest 1,000,000 acres and to purchase and develop the necessary nurseries. Since the money is available until used, it may be more than eleven years before the program is completed.

This is the largest and most constructive forestry plan yet adopted by any state. New York for several years has been acquiring and reforesting lands under special appropriations. During the past year, for example, the Conservation Department acquried nearly 70,000 acres, only about 26,000 acres of which are in line with the policy now permanently established by the new amendment. The remainder is largely within the preserve boundaries and is forever to be kept in a wild forest state. In 1931 the state planted more than 20,000,000 trees outside the preserves, as compared to 5,357,919 in 1930 and 1,660,000 in 1929. Heretofore the acquisition and reforestation of lands outside the parks has continued more or less without plan and has depended upon the vagaries of legislative action. The new amendment changes the uncertain year-to-year scheme to a mandate by the people to their representatives in the legislature. Furthermore it coalesces the reforestation work into a definite plan and also provides for its financing on a pay-as-you-go basis instead of on bonds.

The principal stimulus and motive behind the amendment is the realization that marginal farms are being abandoned at an alarmingly rapid rate and that this creation of idle lands is fraught with serious consequences. Since 1880 the abandonment has averaged about 40,000 acres per year. Since the war it has reached 250,000 acres per year. Between 4,000,000 and 5,000,000 acres are now lying idle as a result. One million acres it was found, could be purchased in manageable units for less than $10.00 per acre. The purchases in 1931 averaged about $7.00 per acre. The initial cost plus the cost of planting, protection and care, are expected to total $20.00 per acre. Cost of planting is, however, due for a material decrease because of the development of a planting machine. In 1931, planting by hand cost an average of $5.69 per thousand trees, while machine planting where it was feasible cost on an average only $2.50 per thousand.

New York's enlarged forestry program is now an assured fact. No longer a political issue nor a subject to be campaigned for, it is now a matter requiring only technical accomplishment. Once more New York has taken steps to widen its lead over other states in forestry matters. As the Nation's largest reforestation project, larger even than that of the federal government, much interest will be shown in its progress. Many problems will arise that will tax to the utmost the knowledge and skill of the state's foresters. Which lands are best suited to forestry, which should be left for other purposes and which should be acquired first? Should the reforestation be with conifers or hardwoods? Is pure planting of conifers an invitation for future soil, insect, disease and marketing troubles? If mixed planting is wiser, what proportions of which species should be used? What provision should be made to arrest soil erosion and to rehabilitate the depleted soil fertility where special attention to these factors is required? Which

areas should be planted and managed primarily for protection forest purposes and which for production forests? How can aesthetics, game propagation and commercial tree growing be coördinated? All of these and others will be big problems to the foresters who are charged to do the job. New York is fortunate in already having a large, skilled and experienced forestry personnel in its department of conservation, nevertheless, it has before it the biggest forestry task ever set a state department. The general public will stand by and look on as a critical though non-technical observer. The forestry profession will look on with the greatest interest and not the least concern that the proper technique is followed.

All power and Godspeed to New York's foresters.

THE RELATION OF CERTAIN FOREST CONDITIONS TO THE QUALITY AND VALUE OF SECOND-GROWTH LOBLOLLY PINE LUMBER

By BENSON H. PAUL

Silviculturist, Forest Products Laboratory[1]

Management plans too frequently are aimed at volume production alone when the per acre value of the product grown should be the criterion. The author, a pioneer in America in investigations dealing with relations between silvicultural treatments and quality of the product, discusses for loblolly pine the influence upon value of such factors as tree diameter, uniformity of rate of growth, density of stand, competition with admixtures of hardwoods, crown spread, and others. The results of his studies indicate clearly that rapid growth and high volume yields are not necessarily concomitant with high value.

COMPARATIVE studies of forest conditions and the quality and quantity of lumber obtained from second-growth stands of loblolly pine show that the employment of certain silvicultural practices at the beginning and during the development of the second-growth stands will increase the net value of the lumber obtained from a unit area of forest.

The studies are based upon sample plots representing different existing forest conditions in the stands under consideration. The plots consisted of portions of areas cut over in logging and milling studies conducted by the Forest Products Laboratory in coöperation with the regional experiment stations, local forest and lumber organizations, and lumber companies.

The forest conditions on each of the plots were carefully studied; all of the trees were numbered, mapped, and specially marked so that at any future time the location of each tree could easily be ascertained. The amount of lumber and the grades cut from each tree were recorded in the logging and milling studies. The lumber values and the logging and milling costs were used to determine the net stumpage value of the timber on each plot. Such an analysis brought out striking contrasts in the net value of sample plots which were adjacent to each other and which under similar conditions of stocking would have been expected to produce lumber of equal grade and value.

The differences in forest conditions responsible for the greatest fluctuations in value were composition of the stand (with respect to age and amount of hardwood species in mixture with the pines) and rate of stocking in pure or nearly pure stands of pine. These factors were found to influence the size of the pine trees, the cost per thousand board feet of logging and milling, the amount of pine lumber, the commercial lumber grades, the specific gravity and strength of the wood, the rate of growth of the trees, and the relative percentages of heartwood and sapwood.

The studies were made in three stands of second-growth southern pine, one in Virginia, one in North Carolina, and one in a mixed stand of loblolly and shortleaf pines in Arkansas. Both oldfield and forest second-growth stands were investigated. The different areas supported age classes ranging principally from 50 to 60 years.

Forest Description

The Virginia and North Carolina stands were located in the Atlantic

[1]Maintained at Madison, Wis., in coöperation with the University of Wisconsin.

Coastal Plain region. The Virginia stand occupied a level area about 10 acres in extent. The surface soil is a sandy loam underlain by a rather impervious subsoil. Adjoining agricultural lands used for production of corn and peanuts have been ditched in order to remove surplus water. The site index height for loblolly pine was placed at 85 feet for dominant loblolly pine trees 50 years of age.

In about 1869 most of the loblolly pine was cut from this forest. Scattered hardwoods and a few old-growth loblolly pine trees left standing at that time remained during the development of the second-growth stand. At the time of the present study the area was predominately stocked with second-growth loblolly timber. Nevertheless many of the old-growth hardwoods had developed wide spreading crowns that in some places excluded the establishment of a new stand of pine.

Age counts of the second-growth loblolly pine stumps revealed the fact that many of the trees were present as advance reproduction in the stand at the time of the cutting 60 years before. This is evidenced by a central core of very narrow growth rings followed by greatly accelerated growth after the 1869 cutting. This core of slow growth consisted usually of from 5 to 15 rings so that even though the exact ages of the trees ranged mostly from 60 to 75 years, the age of the stand might be considered practically as 60 years since the seedling growth in the original forest was practically negligible. The trees 60 years of age or younger did not have the central core of narrow growth rings.

In addition to the second-growth pines in the stand there were present, also, at the time of this study, many small hardwoods in the sapling and small pole stages, numerically greatly outnumbering the pines.

Four permanent sample plots established by the Appalachian Forest Experiment Station were the source of the material used in this investigation. Study plots of one-fourth acre each were selected in order to bring out contrasts in existing forest conditions. The trees on the plots are tabulated by diameter classes in Table 1. This table also includes the rate of stocking per acre for the pines and hardwoods on each plot and the total number of trees per acre.

In North Carolina the loblolly pine forest studied occupied abandoned farm land unused for agriculture for more than 50 years. The soil is a rather stiff clay, with poor subsurface drainage. The trees of the stand ranged from 50 to 60 years in age and could be separated into two areas, one containing trees mostly 52 years of age, and the other trees 60 years of age. The limits of areas containing trees of different age usually were marked by old roads or old fence lines. The stand consisted principally of loblolly pine, but red gum, black gum, and oak trees of the same age as the pines were present in considerable numbers being more prevalent in some places than others. The site index of this area is about 90 feet in height for loblolly pine 50 years of age.

Four permanent sample plots of 2 acres each were established in this stand. Smaller areas for detailed analysis were selected in the permanent sample plots. The number and size of trees by diameter classes and the rate of stocking per acre for the areas selected are given in Table 2.

The Arkansas stand consisted of a mixture of second-growth shortleaf and loblolly pine. Only a few second-growth hardwoods were present. The stand was of even age about 55 years old and stocked in different portions at rates of from 100 to 200 pine trees per acre. The soil is rather heavy but well drained. The site index for the pine trees at 50 years of age was 85 feet. Three tem-

TABLE 1

NUMBER OF TREES IN EACH DIAMETER-INCH CLASS, ¼-ACRE PLOTS, LOBLOLLY PINE AND HARDWOODS, VIRGINIA

D.B.H.	Designation of plots																											
Inches	1-A		1-B		1-C		1-D		2-A		2-B		2-C		2-D		3-A		3-C		3-D		4-A		4-B		4-C	
	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood
3		11		39		19		9		11		18		5		9		23		24		17		19		18		7
4		10		17		17		24		4		12		7		5		13		5		9		10		13	1	10
5		2	1	14		11		4	1	4		12	1	1		5		6	3	6		3		7		4		8
6		3		7		13			3			6	2	2	2	2	3	7	5	7	1	1	2	6	2	7	1	2
7	1	3	4	5		2		1	2			8	1	2	1	2	2	4	1	1	3	1		3	4	3	2	3
8	5	1	3		6	2	1	1	3	1	2	5	1		3	2	6	2	6	3	4	1	2	2	6	2	3	4
9			8	2		2	2		1	5	6	4	1	4			1	4	2	1	3	3	1	3	5	1	4	2
10	1		4	3	1		5		2	5	2		3	1		3	8	3	1	3	6	2	5		3		2	3
11	2	1	1	1	3	1	4		2	1	4	2		2	5	1		1	2	1	3	1	4	3	2		2	
12	1	7	5		3	4	2	1	6	1	7	1	2	2		4	8		1	2	4	1	6		1		1	
13	1	1	2		3		6		1	1	5		2	1	1	2	1	1	2		2		5		1	1	5	
14	2	1	3		2	2	3	1		2	4			2	1		4	2	1		6	2	2		3	1	2	
15	1	3	2		2		6	1	1	1	5				1				2		1	2	2		1		1	
16	1	1	4		3		3				2						1		1	1	3		3		2			
17	1	1	1		1		2			1	2	2				1	2				1				1		2	1
18				2	1	1	1	1			1				1		1				1	2	2		1	2	3	
19			1		2		2										1				1		1		1		1	
20			3													1				2							1	1
21										1							1								1	1		
22			1	1											1													
23		1												1														
24						1				1																		
25						1																						
26										5																1		
27		1								1						1												
28										2																		
29																1												
30																												
31																												
Number of trees per acre	64	188	172	364	108	304	148	172	88	188	160	280	52	128	64	156	156	264	108	224	156	180	140	212	136	216	124	164
Total	252		536		412		320		276		440		180		220		420		332		336		352		352		288	

TABLE 2

NUMBER OF TREES IN EACH DIAMETER-INCH CLASS, SUBPLOTS, LOBLOLLY PINE AND HARDWOODS, NORTH CAROLINA

D.B.H.	Designation and area of subplots																			
	1-A 1 acre		2-A 1 acre		2-B 1 acre		3-A 1/10 acre		3-B ½ acre		3-C ½ acre		4-A ½ acre		4-B ½ acre		4-C ½ acre		4-D ½ acre	
Inches	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood	Pine	Hard-wood
3		31	5	85	2	31		2		16		9		25		26		30		33
4		21	6	71	2	23		1		7		7		12		16		21		19
5	1	11	3	28	2	12		1		3		2		11		14		17	1	28
6	13	14	9	13	3	13	1	1	1	4			1	14	1	17		9	2	13
7	22	6	11	3	8	3			2		2	4	6	7	3	15	4	2		11
8	43	3	11	10	11	2	1	3	5	2	7	3	8	7	4	18	8	6	3	4
9	46	1	5	7	19	6	3		12	1	12	1	15	7	7	14	10	1	5	4
10	36	8	16	3	19	4	9	1	10	1	18	2	19	4	7	2	14	7	6	1
11	24	2	9	2	18	4	3		9	1	22		14	3	10	4	12	3	5	1
12	24	2	14	3	24	4	3		11	1	13		13		5	1	8	3	5	1
13	22	2	8	2	20	2	2		7		9		5	1	10	1	10	4	7	
14	8	1	16	1	15	3	1		10		10		8		8		5		10	
15	8		10		13		1		5		6		2		6		8		10	
16	5		9	2	11				1		3		5		5		3	1	9	
17			7		6				3		3	1	2				3		5	
18	1		2		6		1		2		1	1			3		1		5	
19			6		1				2	1			1		2		2			
20			3		3				1											
21			2		1				1											
22			1																	
Number of trees per acre	253	102	153	230	184	107	250	90	164	74	212	60	198	182	142	256	176	208	146	230
Total	355		383		291		340		238		272		370		398		384		376	

porary sample plots of one-fourth acre each furnished the material for investigation. The number and size of pine trees on each of the plots is given in Table 3.

Relation of Stand Conditions to Lumber Production and Lumber Grades[2]

Comparisons of the stand inventories of the plots as shown in Tables 1, 2, and 3, reveal great variations in the rate of stocking, in the proportion of pine and hardwoods, and in the number of trees in different size classes.

These variations occurring in the character of the stand on the various plots show, on a small scale, how the prevailing forest condition may influence the total profit as well as the grades and quality of the lumber to be derived from a woodland.

In the Virginia stand a distinct disadvantage is seen in the presence of the old-growth hardwoods which remained from the previous stand. On four out of 13 one-fourth acre plots containing merchantable hardwood trees the hardwood lumber turned out to have a negative value after allowance was made for the cost of cutting, handling, and manufacturing.

The large old-growth hardwoods resulted in a lower yield of pine on the plots where they occurred since as a rule their spreading crowns shaded large areas and prevented the growth of pine trees. The total stand in board feet per acre of pine and hardwoods as determined by a mill tally of the lumber from the trees cut and assuming equal production by the pine trees of equal diameters left standing for each of the plots follows in Table 4. The percentage of lumber in the B and Better grade for each plot is included for comparison.

A mixture of hardwoods with pines has long been considered advisable, first from the standpoint of maintaining satisfactory soil conditions and second because of the influence of the dense shade of the hardwood trees in clearing branches from the stems of the conifers; such a mixture resulting in the production of lumber of higher grade. However, from the standpoint of profit over a given rotation, it appears from the data at hand that the most favorable results from a hardwood mixture are obtained when the number of hardwood trees is limited or

Table 3

NUMBER OF TREES IN EACH DIAMETER-INCH CLASS, ¼-ACRE PLOTS, LOBLOLLY AND SHORTLEAF PINE, ARKANSAS

D.B.H.	Plot 1	Plot 2	Plot 3
Inches			
6	—	5	—
7	2	—	2
8	6	5	1
9	3	3	5
10	5	5	1
11	9	6	1
12	8	5	3
13	6	4	2
14	4	6	5
15	2	2	1
16	2	2	1
17	—	3	2
18	3	—	1
19	—	1	1
20	—	—	1
21	—	—	—
22	—	—	1
Number of trees per acre	200	188	112

[2]Selected grades provide for good appearance and finishing qualities. Grade B and Better is a select grade that is suitable for natural finishes. It is described in the American Lumber Standards as allowing a few small defects or blemishes. Common grades contain defects that detract from a finish appearance but are suitable for general utility and construction purposes. No. 1 Common is described in the American Lumber Standards as sound and tight-knotted stock in which the size of the detects is limited.

here the hardwood trees are relatively maller than the pine and confined prinipally to an intermediate or subordinate osition in the stand.

While the presence of a considerable umber of second-growth hardwoods over inches d.b.h. in different portions of he stands has somewhat improved the umber grades of the second-growth loblolly pines among which they were growing in comparison with areas having relatively few hardwood trees, this has been accomplished at a sacrifice in the total yield of pine lumber and at a lower per acre profit. This fact may be seen by comparing the total net value per acre of plots containing the greatest number of second-growth hardwoods with those having relatively few hardwood trees or only hardwood trees of small size.[3] Compare

TABLE 4

OTAL YIELD PER ACRE OF MERCHANTABLE LUMBER (MILL TALLY) AND PERCENTAGE OF B AND BETTER PINE LUMBER ON SAMPLE PLOTS

Location and Plot No.	Loblolly pine lumber		Hardwood lumber	Total
	Board feet	Per cent B & Better grade	Board feet	Board feet
Virginia				
1A	6,212	15.6	6,476	12,688
1B	20,776	17.2	768	21,544
1C	15,496	18.0	2,684	18,180
1D	23,112	15.6	——	23,112
2A	5,488	24.9	2,360	7,848
2B	20,116	16.3	2,052	22,168
2C	2,668	No pine cut	6,588	9,256
2D	7,232	17.0	6,216	13,448
3A	16,516	17.9	604	17,120
3C	6,428	22.7	2,684	9,112
3D	17,236	15.9	2,880	20,116
4A	17,640	19.1	196	17,836
4B	13,884	21.3	4,352	18,236
4C	15,844	19.8	2,788	18,632
North Carolina				
1A	17,845	4.2	1,395	19,240
2A	17,408	4.2	1,818	19,226
2B	22,623	3.8	1,976	24,599
4A	20,844	9.5	1,986	22,830
4B	21,262	13.5	3,548	24,810
4C	23,366	12.1	3,626	26,992
4D	26,270	9.7	910	27,180
3A	28,090	7.7	1,490	29,580
3B	26,198	7.2	1,470	27,668
3C	29,060	10.3	1,096	30,156
Arkansas				
1	26,732	4.4	——	26,732
2	23,400	2.5	——	23,400
3	17,776	9.2	——	17,776

[3]The value of the younger hardwoods is questionable since it would take another rotation of pine before they would reach a profitable size. Species that could be used for pulpwood might yield sufficient return to pay for cutting and removal. Girdling the small remaining hardwood might be advisable in order to promote the restocking of the stand of pine.

Virginia plots 1A, 2A, and 2C with 1B, 1D, and 2B. (Figure 1 and Table 5.) Although Plot 1D furnished only 15.4 per cent B and Better lumber, the total amount of pine lumber and the net value per acre of all of the lumber from this plot exceeded all other plots in the stand. The indications are that equally favorable results might have been obtained from the whole area if steps had been taken at the time of the earlier cutting to rid the area of old defective hardwoods and thereby allow a full stocking of pine. In other places a reduction in the number and size of the pine trees by the presence of too many young hardwoods occasioned a greater loss in value than was offset by the production of a slightly higher percentage of lumber of higher grade.

One thing which stands out conspicuously in this investigation is the influence of the old-growth hold-over hardwoods on the value per acre of the stand. Plots 1A, 2A, and 2C are examples. The net value per acre of the lumber on these plots equals only about one-fourth to one-half of that of the adjacent plots. It is evident that the presence of large-sized hardwoods in numbers of from 20 to 40 per acre have resulted in net losses per acre in lumber value of from $100.00 to $150.00 or more.

The bar charts presented in Figures 1, 2, and 3 show the total basal area of the stand on each plot, the basal area of hardwoods and pine, and the gross and net values of the merchantable stand and profitable pine stand. By profitable pine stand is meant only pine trees which pro-

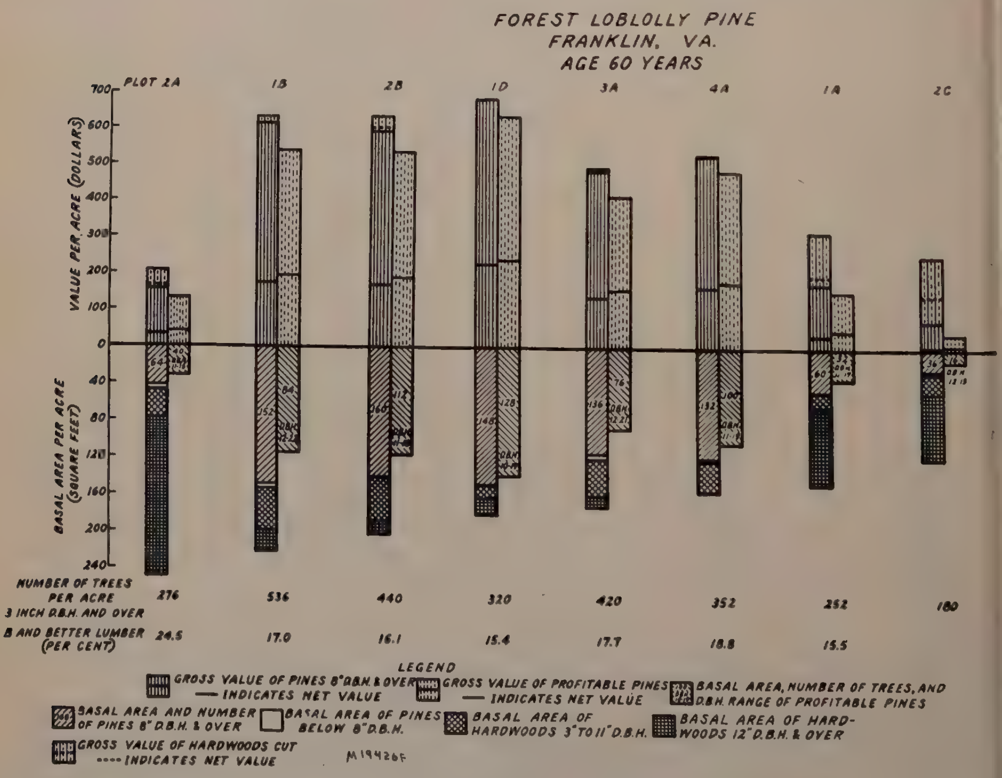

FIG. 1.—Total basal area of pines and hardwoods, basal area of profitable pine trees, and gross and net profit of merchantable and profitable trees, 60-year loblolly pine, Virginia.

uced lumber of sufficient amount or uality to more than pay for the cost of ogging and milling. (Cost of timber rowing is not considered in this paper.) he size of the smallest profitable tree as found to vary considerably on differ- nt plots and ranged from 9 inches to 13 nches d.b.h. Profitable 9 or 10-inch trees roduced rather high percentages of B nd Better lumber. These trees grew in rowded portions of the stand where arly natural pruning occurred. Such rees would have yielded a still greater alue if after natural pruning had taken lace the stands had been thinned so that hese particular trees might have main- ained a more rapid growth rate and at- ained greater size.

A comparison of the basal area ratio f pines and hardwood in different plots and in different stands shows in general an increase in the percentage of B and Better lumber with an increase in the basal area of hardwoods. (Figure 4.) This relationship was more uniform in the stands in which the hardwoods were well mixed with pine trees of about the same age. However, the highest net value per acre was found where the basal area of hardwoods did not exceed 25 per cent of the basal area of the stand.

Relation of Growing Space to Grades

The lateral projection of the crown of a tree affords a measure of its growing space. A comparison of crown spread and grades shows a rather definite relation between crown diameter and the percentage of lumber in the upper grades

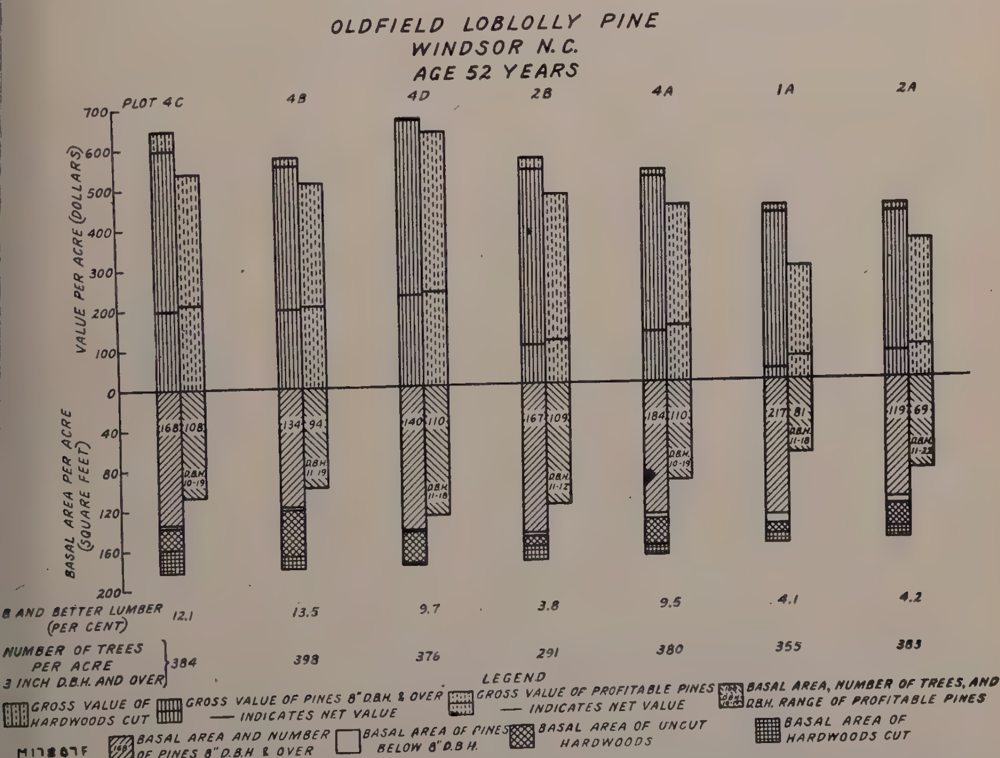

Fig. 2—Total basal area of pines and hardwoods, basal area of profitable pine trees, and gross and net profit of merchantable and profitable trees, 52-year loblolly pine, North Carolina.

from trees of different crown size, or, in other words, of different numbers of trees per acre.

The logging and milling study in the Virginia stand shows a general tendency toward the production of a higher percentage of B and Better lumber as the diameter of the tree crowns increased. This is attributed to the fact that the trees with larger crowns maintained a faster rate of growth and produced a considerable quantity of clear wood after natural pruning of the lower portion of the bole had occurred. This is probably the result of a change from rather crowded forest conditions during th early life of the stand to more open con ditions later on.

In the North Carolina oldfield stand a yield of 13 per cent of B and Better pine lumber was obtained from a stock ing of 142 pine trees and 144 hardwood trees over 6 inches d.b.h. per acre in the 52-year age class and 10.3 per cent B and Better pine lumber from a stocking of 212 pine trees and 14 hardwood trees over 6 inches d.b.h. in the 60-year age class. In each age class more dense or more open stocking resulted in a lower percentage of B and Better lumber. In

TABLE 5

GROSS AND NET VALUE PER ACRE OF MERCHANTABLE LOBLOLLY PINE AND HARDWOODS AND PROFITABLE LOBLOLLY PINE TREES—SAMPLE PLOTS

Location	Plot No.	Value per acre: Merchantable hardwoods		Merchantable pine		Profitable pine trees	
		Gross	Net	Gross	Net	Gross	Net
Arkansas	2	$ —	$—	$559	$ 15	$396	$ 43
Arkansas	1	—	—	631	13	375	47
Arkansas	3	—	—	468	75	390	88
North Carolina	1A	20	0	418	28	285	58
North Carolina	2A	21	0	418	67	349	82
North Carolina	2B	28	0	534	95	471	108
North Carolina	4A	16	0	514	126	441	140
North Carolina	3A	—	—	617	133	478	152
North Carolina	3B	23	7	586	191	535	201
North Carolina	3C	14	0	656	191	587	204
North Carolina	4B	22	0	553	197	510	204
North Carolina	4C	48	0	598	199	539	211
North Carolina	4D	6	0	661	226	631	233
Virginia	2C	178	58	74	6	39	10
Virginia	2A	49	4	158	32	135	39
Virginia	1A	49	11	175	34	153	47
Virginia	3C	59	11	184	36	156	49
Virginia	2D	168	65	213	71	199	76
Virginia	4B	93	9	408	125	359	145
Virginia	3D	54	0	500	136	455	154
Virginia	3A	11	0	483	136	414	158
Virginia	1C	61	10	458	145	428	163
Virginia	4A	3	0	527	164	483	177
Virginia	4C	60	22	489	173	451	186
Virginia	2B	41	8	593	168	535	188
Virginia	1B	17	0	615	176	540	193
Virginia	1D	—	—	683	228	636	238

e 55-year old Arkansas stand a yield 9.2 per cent of B and Better lumber was ›tained from a rather open stocking of l2 pine trees per acre. The hardwoods in is area were few and of little significance ith respect to lumber grades. However, the Arkansas stand the butt logs had ecome relatively free from side branches t a relatively early age and the subse- uent rapid growth of the trees in the un- rowded portion of the stand had re- ılted in the production of a considerable mount of high grade lumber in the butt ›gs. In the closely stocked portions f the stands mentioned above the trees ith small crowns were of slower growth, specially near the circumference, and ven though they may have been produc- ng clear wood during the same years as the trees with larger crowns, the restricted width of the clear layer in the trees with smaller crowns made the separation of it from the knotty inner portion of the tree impossible in the course of lumber manufacture.

There is an opposite tendency in the relation of crown size to the percentage yield of No. 1 and C lumber from that found with the B and Better grade. In this case the trees with smaller crowns yield higher percentages of No. 1 and C than the trees with larger crowns. This may be explained by the fact that the trees with small crowns standing closer together than the large crowned trees shed their lateral branches before they had developed to a stage which would

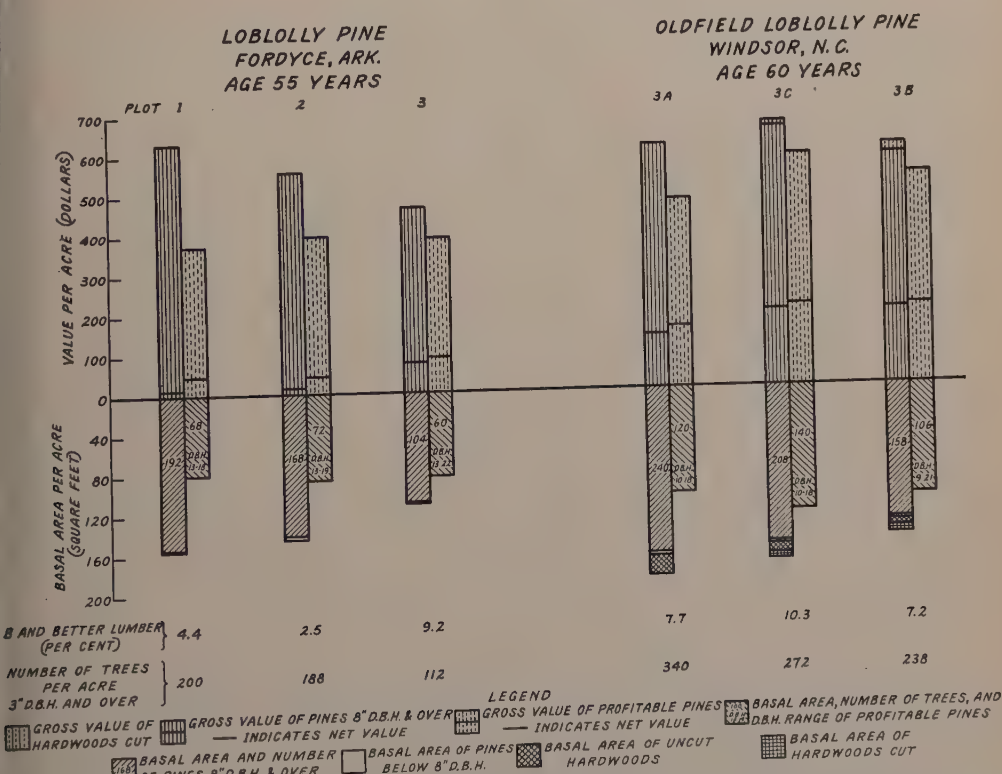

FIG. 3.—Total basal area of pines and hardwoods, basal area of profitable pine trees, and gross and net profit of merchantable and profitable trees, 55-year shortleaf and loblolly pine, Arkansas, and 60-year old loblolly pine, North Carolina.

produce large knots in the resulting lumber.

In the remaining grades no definite relation could be seen between crown size and the percentage of lumber produced in any grade.

Rate of Growth

The effect of stand conditions upon rate of growth is illustrated by a curve showing the relation between the width of the tree crowns and the diameter increase of the trees during the last 10 years. (Figure 5.) The growth in diameter in 10 years varies from an average of about 0.5 inch for trees having crowns less than 10 feet in diameter to about 2.0 inches for trees with crowns over 20 feet in diameter. The curve in Figure 5 is based upon crown and diameter measurements of 485 trees in the North Carolina stand.

Heartwood

Lumber from second-growth loblol[ly] pine contains a smaller percentage [of] heartwood[4] than virgin growth trees [of] this species. The proportionate amou[nt] of heartwood was found to vary wit[h] the rate of growth and growing space [of] the individual trees in an even-age[d] second-growth stand. (Figure 6.) Th[e] trees of smaller diameter from the mo[re] closely stocked areas have, as a rule, [a] greater heartwood percentage than th[e] large trees of more rapid growth whic[h] have been less severely crowded. Th[e] percentage of heartwood is important i[n] the natural durability of timber whe[n] used in damp places.

Relation of Growing Space to Valu[e]

In working out a relation betwee[n] growing space and value per tree of th[e]

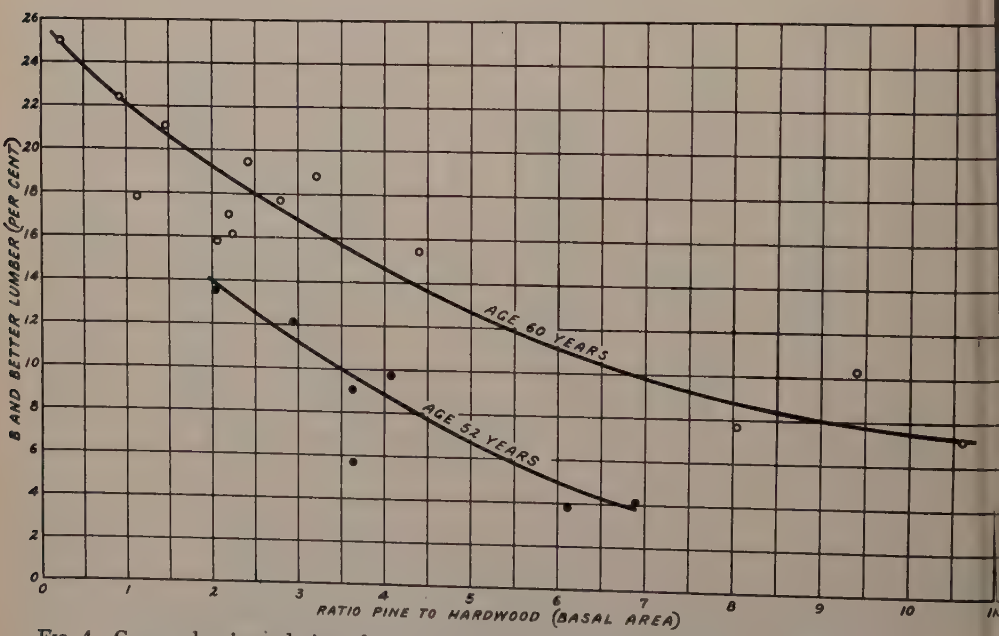

Fig. 4—Curves showing relation of production of B and better lumber to the ratio of pine and hardwood in second-growth loblolly pine stands.

[4]Heartwood in Second-Growth Southern Pines, by B. H. Paul, Southern Lumberman, Oct. 1, 1930, and Naval Stores Review, Oct. 18, 1930.

second-growth loblolly pine trees in the Virginia stand three groups of crown sizes were considered. These groups included:

1. Trees with crowns from 12 to 17 feet in diameter.

2. Trees with crowns from 18 to 24 feet in diameter.

3. Trees with crowns 25 feet and more in diameter.

The average crown spread, the average d.b.h., and the average net value of the trees in each group are shown in Table 6. In addition, the possible results from maintaining a forest in the average condition indicated by the three crown-size groups is included:

trees which have matured in more open stands.

For lumber production, however, it appears that a stand of medium stocking is the most profitable. The indicated difference in value of $163.47 per acre between the first and second-sized groups shows the advisability of thinning densely stocked stands. It is likely also that similarly favorable results with respect to improved grades could be obtained by pruning[6] the lower portions of the stems of trees in more open portions of the stand before the trees have become large enough to develop lateral branches which will influence the lumber grade outside of a small central core.

TABLE 6

RELATION OF CROWN SPREAD, AND TREE DIAMETER TO NET VALUE

Crown size and value of average tree in different crown-size groups				Possible return, number of trees and lumber value of a fully stocked acre		
Crown diameter groups: Range	Crown diameter groups: Average	Average d.b.h. of trees included	Average net value per tree	No. of trees	D.b.h. range	Total net value
Feet	Feet	Inches			Inches	
12-17	14	12.6	$0.79	171	10-16	$135.09
18-24	20	15.7	3.11	96	11-19	298.56
25+	28	18.3	4.45	54	15-22	240.30

The above is based upon the value of the stand for lumber production. For the production of other products, such as poles and piling, the trees of smaller diameter may have a greater value. Definite information on this phase of utilization should be taken into consideration in working out a management plan for a particular forest.

The results of the specific gravity determinations given later show that the trees in the smaller sized group have heavier wood and consequently greater strength.[5] This makes them more suitable for use as poles and piling than

SPECIFIC GRAVITY DETERMINATIONS

An investigation of the specific gravity of the wood from the second-growth loblolly pine trees of different diameters showed that in general the wood of the trees 10 inches and over in diameter decreased with increasing diameters. (See Figures 7 and 8.) The curve in Figure 7 shows an average specific gravity of 0.49 for 10-inch trees, of about 0.47 for 16-inch trees, and 0.41 for 21-inch trees. There was a slight average decrease for the specific gravity of 9-inch pine trees in comparison with the 10-inch trees.

[5]Producing Dense Southern Pine Timber in Second-Growth Forests, by B. H. Paul, Southern Lumberman, Sept. 17, 1927.

[6]Pruning Young Loblolly Pine Trees Makes Timber Growing More Profitable, by B. H. Paul, Southern Lumber Journal, Aug., 1931, and Louisiana Conservation Review, Sept., 1931.

These results are based upon specific gravity determination of the entire tree cross section taken at a point 16 feet above the stump in 45 trees ranging from about 9 to 22 inches d.b.h. selected at random in the forest under consideration. Similar results were obtained in specific gravity determinations of the wood for representative trees in the stands studied in North Carolina. The lower specific gravity for the trees of larger diameter is attributed to their large crown size, and more rapid growth, especially during their earlier years. In previous investigations[7] it was found that second-growth southern pine trees with larger crowns produce wider growth rings which contain wood of lower density than was found in the smaller crowned trees. The relation of the rate of growth to specific gravity in these trees is shown in the following. The average specific gravity of 27 trees 14 to 22 inches in diameter was 0.447. In 22 trees the specific gravity of the wood of the last 30 years averaged 0.471 and the wood formed more than 30 years ago, 0.423. The rate of growth for the two periods averaged 12 and 7 rings per inch, respectively. On the other hand, in five trees which ranged from 16 inches to 21 inches d.b.h., the wood produced during the last 30 years averaged 0.495 and that produced earlier 0.485. The values corresponded to rates of growth of 10 and 8 rings per inch respectively. These trees produced wood of uniform weight and although their rate of growth was not rapid, it was main-

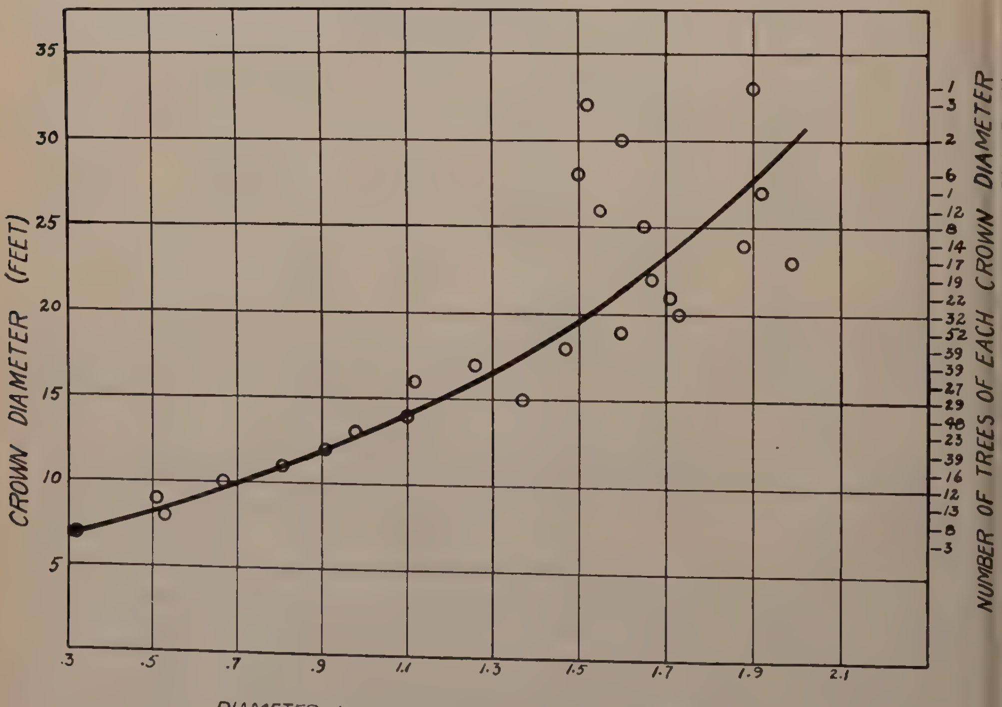

FIG. 5.—Relation of crown diameter to diameter increase of tree stems during last 10 years—loblolly pine, North Carolina.

[7]The Application of Silviculture in Controlling the Specific Gravity of Wood, by Benson H. Paul, U. S. Dept. Agr. Technical Bulletin No. 168, January, 1930.

ained at a fairly constant rate and these rees were much above the average size of the second-growth pine trees in the tand.

Variation in weight of the wood within he cross section of second-growth pine rees has been found in earlier investigaions[5] to be caused principally by sparse tocking of the trees in their early years of growth and a gradual reduction of growing space as the trees became larger and the forest more fully stocked. In sawing lumber from trees having wood hat varies greatly in weight from the center outward, it is difficult to obtain boards of uniform density throughout. Such nonuniformity of structure may give rise to warping.[8]

Strength Tests

Bolts from 10 trees each in the Virginia and North Carolina stands, including a range of diameters, were tested in accordance with the standard Forest Products Laboratory procedure for determining the mechanical properties of wood. The results of these tests show in general higher strength values for the smaller trees of slower growth and progressively decreasing values with increase in size for trees of 10 inches d.b.h. and over. The average results of tests of the bending strength are presented in Figure 8. In general the curve for bending strength in relation to the d.b.h. of the trees follows very closely the curve for the specific gravity. (Compare Figures 7 and 8.)

The average bending strength (modulus of rupture) dropped from an average of about 7,800 pounds per square inch in 10-inch trees to 7,500 pounds in 15-inch trees, and to 5,800 pounds per

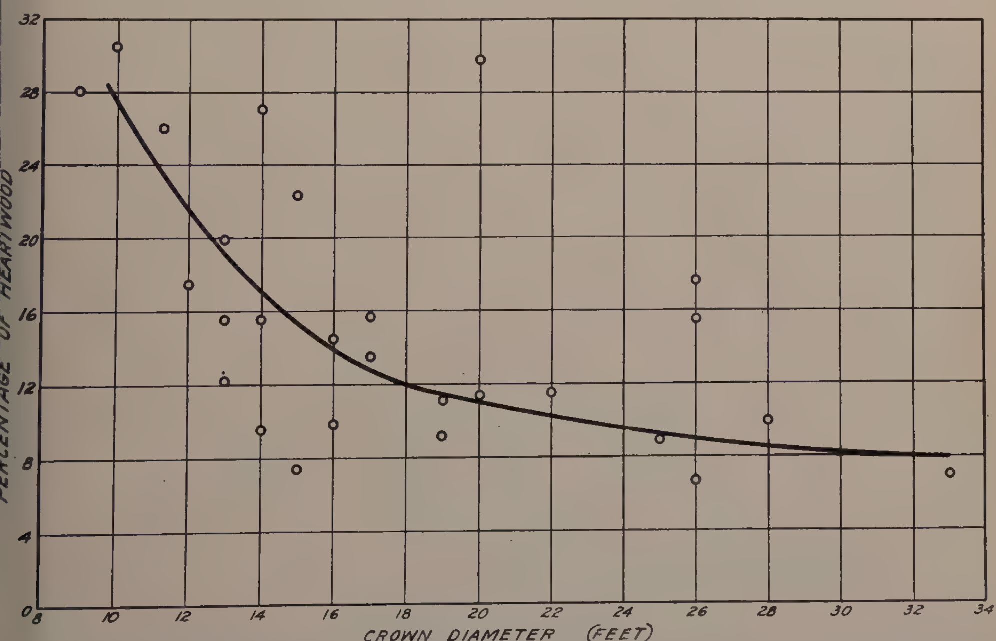

Fig. 6.—Relation of crown diameter to the percentage of heartwood in the tree cross section measured 16 feet above the ground—loblolly pine, butt logs, Windsor, North Carolina.

[8]Cupping of Plain-Sawed Lumber and Checking of Timbers of Longleaf Pine of Slow, Medium, and Rapid Growth, by B. H. Paul, Southern Lumberman, Sept. 1, 1930.

square inch in 20-inch trees. There were often rather sharp differences in the strength of test sticks from different parts of the same cross section. In general the differences in the strength of radially adjacent test sticks was smaller in the trees which exhibited a fairly uniform growth rate from the center outward as illustrated by Figure 9.

Summary and Conclusions

A comparison of forest conditions on sample plots and lumber grades obtained in logging and milling studies in second growth loblolly pine stands in Virginia, North Carolina, and Arkansas show the following:

The total net per acre lumber values

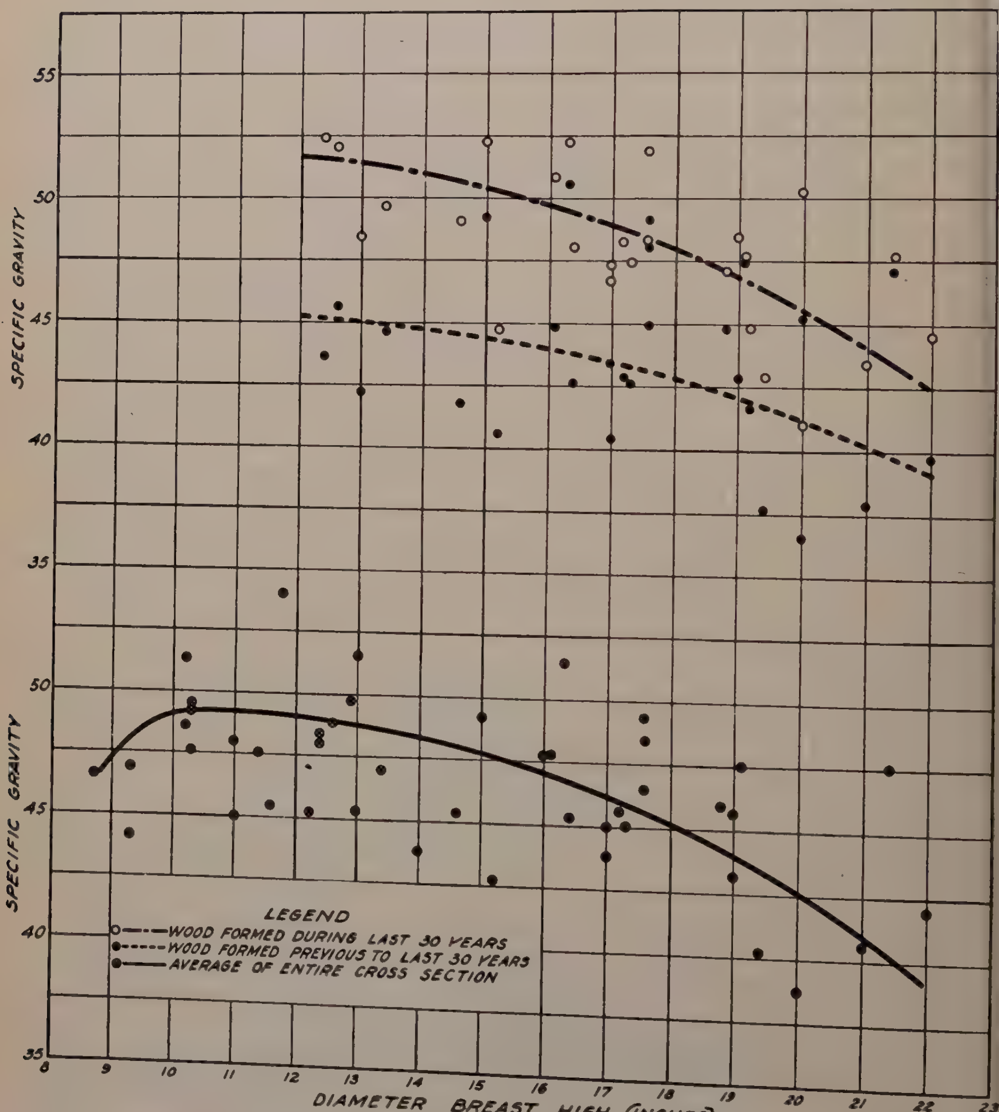

Fig. 7—Relation of breast high diameter to average specific gravity and to specific gravity of inner and outer portions of even-aged second-growth loblolly pine trees, Virginia.

ere from \$100 to \$150 higher in plots ithout old-growth hardwoods than in ljoining areas containing old-growth ardwoods left from an earlier stand.

Plots having a considerable number of cond-growth hardwoods in mixture with e pines showed increases in the percent- ge of B and Better lumber as the basal ea of the hardwoods increased. There as, however, a lowering of the net value er acre of the lumber obtained when the asal area of hardwoods exceeded 25 per ent of the basal area of the stand, since e total amount of pine lumber was de- reased on account of the space occupied y the hardwoods, most of which were nmerchantable.

In loblolly pine or other dense second- rowth stands a low yield of B and Better mber may not be the result of a notty condition of the trees but rather e small size and slow growth of the ees makes impracticable the separation f the inner knotty portion and the outer lean portion in the process of lumber anufacture.

The relation of growing space, as mea- ured by crown size, to the grades and alues of lumber obtained from even- ged second-growth loblolly pine trees in e stands considered here indicates that e greatest profit per tree may be ob- ained from the trees with large crowns (over 24 feet in diameter), but the greatest profit per acre is obtained when the stand is fully stocked with trees having crowns of medium size.

The rate of growth in diameter during the last 10 years was proportional to the size of the crowns of the trees.

The average specific gravity of tree cross sections averaged lowest for the larger trees and gradually increased in the trees of small diameter to 10-inch trees but was slightly lower for 9-inch trees than for 10-inch trees.

The curve for the average bending strength of the trees of different diameters closely followed the trend of the curve showing the relation of diameter and average specific gravity.

With a few exceptions the wood of the last 20 or 30 years in the trees averaged considerably heavier and stronger than the wood produced during the earlier years of the trees.

An examination of the details of the forest conditions and the stands of the various plots included in the foregoing investigations indicates several ways in which silvicultural practice could have been used to increase the yield, the lumber grade, and the net profit derived.

1. An outstanding feature in the Virginia study is small net profit obtained from plots containing old-growth hard-

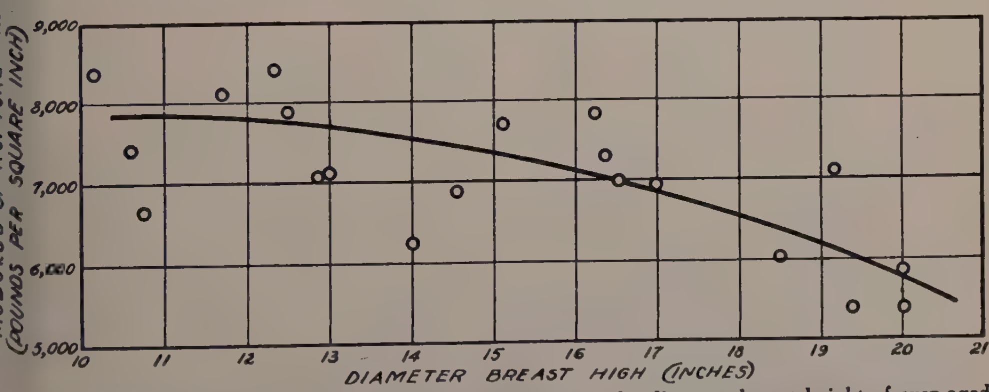

FIG. 8.—Relation of bending strength (modulus of rupture) to the diameter breast height of even-aged second-growth loblolly pine.

woods remaining from the earlier stand. Girdling of the hardwoods remaining at the time of the first cutting 60 years earlier would have made possible increases in net value of $100 to $150 per acre on certain of the plots by allowing replacement of the old defective "wolf" hardwoods with pine.

2. Although, as determined by logging and milling costs, on the average loblolly pine trees less than 13 inches d.b.h. did not pay their way, in certain of the plots loblolly pine trees as small as 10 or 11 inches d.b.h. proved to be profitable because of the high percentage of B and Better lumber which they produced. Such trees could have been made even more profitable if their growth had been accelerated by thinnings made after the stems were clear of branches and the production of clear wood had begun.

3. The best results with respect to grade and net value in second-growth loblolly pine are obtained when the conditions during the early life of the stand are such that natural pruning of the side branches takes place followed later by stand conditions that promote fairly rapid growth and the development of individual trees of larger size. Stands left to develop without definite silvicultural treatment rarely attain this combination of conditions; either the stands sufficiently dense to bring about natural pruning in early life remain congested and contain only small trees that can not be handled with profit or stands insufficiently stocked in early life remain limby and produce only lumber of low grade.

4. In loblolly pine stands of even age the rate of growth and relative size of tree determines, within certain limits, the weight and strength of the wood. The wood of trees of relatively slow growth averaged heavier and stronger than that of trees of the same age but of more rapid growth. Since the wood of fairly wide-growth rings in the center of the trees was found to be lighter and weaker than wood of slower growth toward the periphery of the same trees it is evident that silvicultural conditions which would have restricted growth in diameter during the early years of the stand would have caused the production of heavier and stronger wood at that time and resulted in greater uniformity of weight and

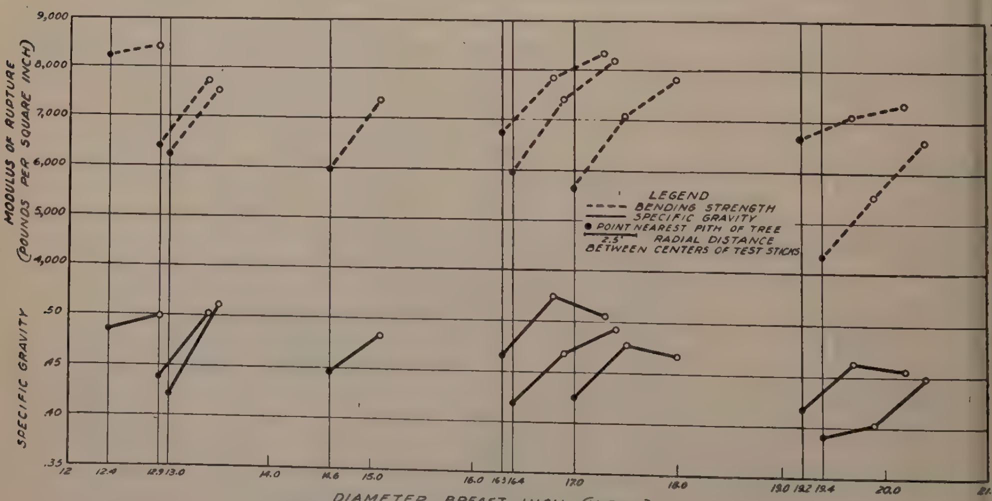

FIG. 9—Radial variation in specific gravity and bending strength (modulus of rupture) in even-aged second-growth loblolly pine trees of different diameters.

ength throughout the tree cross sections. On a basis of net values shown by the ots studied, it appears fairly evident at limited expenditures in such silvicul-ral practices as girdling wolf hard-oods, thinning dense pine stands, and en pruning the lower portions of young pine stems will be warranted fully by the greater net profit obtained.

The results of the foregoing investigation emphasize the need of further investigation of the application of practical silvicultural principles to the business of timber growing.

"The Baobab (*Adansonia digitata*) surpasses even the trees of California in grandeur and antiquity. It is the oldest vegetable monument on earth. Its stem is only from ten to twelve feet in height, but of immense proportions, for it is thirty-four feet in diameter. This colossal circumference is an absolute necessity; because, from its summit it unfolds so vast a leaf-crown that it can only be supported on so massive a foundation. . . . The leaves of the Baobab are palmate, and forcibly remind us of the horse-chestnut,—being divided to the leaf-stalk. It is covered with great Malvaceous-like flowers, which droop on their peduncles. The fruit is about the size of a small gourd.

"In its native country this tree bears a name which signifies a thousand years. Adanson noticed one in the Cape de Verd Islands, off the coast of Africa, which had been observed by two English travellers three centuries earlier; he found within its trunk the inscription which they had graven there, covered over with three hundred woody layers, and thus was enabled to estimate the rate of increase of the stem in three centuries. With this measure he succeeded in estimating the number of years' growth of the entire stem, and in ascertaining the age of the tree, which he found to be 5150 years."

What May Be Learned From a Tree, by Harland Coultas, 1860.

THE EFFECT OF BLACK LOCUST ON SOIL NITROGEN AND GROWTH OF CATALPA[1]

By ARTHUR C. McINTYRE[2] and C. D. JEFFRIES[3]

Pennsylvania State Forest School

Black locust, being a legume, enriches soil fertility through the nitrifying bacteria of the root nodules. It should, therefore, have the effect of stimulating the growth of other species planted in association with it. The authors studied the effect of locust upon catalpa in a plantation containing both species and found a marked growth improvement. Their data are reported here.

BLACK LOCUST (*Robinia psuedoacacia* L.) is a member of the family Leguminosae. Sudworth (18) lists 20 genera containing forty-three tree species as members of this family. Only two species are of commercial importance:—black locust and honey locust (*Gleditsia triacanthos* L.). On the roots of members of this legume family are to be found small nodules or tubercles, harboring bacteria which, aided by the plant, have the power of fixing nitrogen in the soil. The nodule-forming bacteria on legumes are known as *Bacterium radicicola*.[4] They have been classified by groups, members of which show distinct characteristics. The bacteria associated with black locust are placed in Group XI and will not successfully cross inoculate other members of the legume family (21). Agronomists advocate the inclusion of a legume in farm crop rotations. Studies of soils following the growing of clovers, alfalfa, peas, etc., have demonstrated that they have been definitely benefited by these crops.

Field crops growing adjacent to black locust plantations have been observed to be more vigorous and larger than in other portions of the field. Cope (7) makes further note of this in New York State. It is well known that shrubs an herbs flourish under stands of blac locust and plantations that are open t stock soon develop a luxuriant stand grasses.

Observations have been made that th size and vigor of certain tree specie growing in mixture with black locust, ex ceeds that of pure stands of these specie on the same site. This was especiall true in several stands of Norway spruc (*Picea abies* L.) and catalpa (*Catalp bignonioides* W.).

Ferguson (11) found that catalp growing in association with black locus showed increased diameter and heigh growth when checked against individual growing on the same site but at a dis tance from the locust. Analysis of soi samples taken from different portions o the stand showed a slightly higher nitro gen content for the samples secured un der the black locust, the per cent of ni trogen for the locust samples being 0.102 for the catalpa adjacent to the locus 0.098, and for the catalpa growing alon 0.089.

Mattoon (14, 15) has observed tha black locust apparently enriched the soil The writers have been told of instances where black walnut, white ash, whit

[1]Contribution from the Departments of Forestry and Agronomy, Pennsylvania State College State College, Pa. Publication authorized by the Director of the Pennsylvania Agricultural Experi ment Station as Technical Paper No. 536.

[2]Instructor in Forest Research.

[3]Assistant Professor of Soil Technology.

[4]They are also called *Rhizobium leguminosium*, but this nomenclature is only used by a few.

ne, red pine, Scotch pine, and white ruce have shown growth acceleration hen grown in mixture with or adjacent black locust.

Observations in the extensive plantaons of the Pennsylvania Railroad seem indicate that many tree species when anted in mixture with black locust are nefited by the association.

Beijerinek (5) has observed that black cust has few and small nodules yet believes that much atmospheric nitron is fixed and that fixation is at a very pid rate, or the nitrogen is fixed by e host plant. The presence of nitrifying cteria in the soil seems essential to vigrous growth and development in black cust. The vigor of the tree and its abily to withstand attacks of the locust rer (*Cyllene cobiniae* Forst) seems be dependent on the numbers of nodles on its roots (14). Black locust is ot exacting in its soil requirements, 8, 12, 15); it grows on poor rocky or ndy soils though it does best on fertile, ell-drained loams.

Legumes do not prefer an acid soil 17, 19). A knowledge of the p^H value f any soil is not sufficient to judge its roductive capacity (10, 3). On praccally all soils, acidity values decrease s soil depth increases. Black locust does ell on the so-called acid soils of Pennylvania such as DeKalb, Berks and Volsia, and the authors believe that facors other than soil acidity particularly the presence of the particular group of bacteria associated with this species, are of more importance.

Healthy planting stock, taken from nurseries where the soil has been inoculated with this group of bacteria, would probably grow well on most planting sites. An experiment embodying this idea was initiated by the Forestry Department at the Pennsylvania State College several years ago but nothing definite can be reported as yet.

Believing that increased amounts of nitrogen made available by the black locust are responsible for accelerated growth of associated species, the authors attempted to measure the affect by securing diameter and height measurements on catalpa growing in mixture with or adjacent to black locust and comparing these data with results of soil analysis in terms of total nitrogen, nitrate nitrogen, and soil reaction. The data were secured in two black locust-catalpa plantations growing on different soils. The data presented in Tables 1 and 2 were obtained in a 20-year old plantation. The spacing was 6 x 6 feet. Both species were planted as pure stands and the blocks were adjacent. The land had a gentle slope to the northeast. The soil type at one end of the plantation (Plot 1) was a Hagerstown clay loam while the soil at the south end of the grove (Plot 2) was slightly rocky and Hagerstown loam.

TABLE 1

EFFECT OF BLACK LOCUST UPON THE SIZE OF CATALPA GROWN WITH OR NEAR IT

	Plot number 1		Plot number 2	
	Average diameter at breast height. Inches	Average total tree height. Feet	Average diameter at breast height. Inches	Average total tree height. Feet
st row	4.20	25.8	3.46	25.1
nd row	4.89	29.8	3.15	25.2
th row	3.26	22.5	3.07	20.6
th row	3.20	19.5	2.38	16.8
th row	1.92	11.7	2.53	14.0
th row	1.91	11.4		

Data in Table 3 were obtained from a 17-year old plantation which was ideally situated for such a study. The land sloped to the east with about a 3 per cent gradient. At the west end of the five-acre area, black locust had been planted pure, then alternate rows of black locust and catalpa, then six rows of catalpa, then alternate rows of white ash and black locust, then black locust, and lastly fourteen rows of catalpa.

The soil appeared to be a Berks loam, shaley phase, though its decided alkalinity raises a question as to its origin. The land had been under cultivation prior to planting, but it seems improbable that heavy liming could account for this extreme alkalinity. The soil samples were taken in October 1930, after tree growth had ceased, and represented the first six or eight inches of soil after the leaf mold had been scraped away. Each sample was made up of soil taken from ten or more places over the unit area and thoroughly mixed by rolling back and forth on heavy paper.

The accumulation of nitrate nitrogen under controlled laboratory conditions has been used by many investigators, notably Waksman (20) Reynolds (16) and others as a measure of the general fertility of the soil. In this study the nitrifying capacity was determined by subtracting the amount of nitrate nitrogen present in the soil as sampled, from that found at the end of a 30-day incubation period. The soils were all incubat at a constant temperature, 22 to 25 degrees C, with a moisture content of abo 22 per cent. Nitrate nitrogen was determined by the Devarda (2) reductio method as modified by Allen (1). Tot nitrogen was determined by the Kjelda (4) method and the p^H values determin electrometrically using the quinhydro electrode (4).

Results of the Study

The results of the study of the 20-yea old plantation are given in Tables 1 ar 2 and Figure 1. Two plots were laid o in this plantation and diameter (d.b.h and total tree height measurements mad These data, (shown in Table 1 und Plots No. 1 and 2) show the decreasi growth of catalpa as the distance fro the adjacent stand of black locust in creases. The first row of catalpa was feet from the block of black locust. Th distance that the black locust roots pen trated into the catalpa plantation is no known but stimulated growth was ap parent as far as the sixth row of catalpa or approximately 36 feet from the blac locust.

In Table 2 are presented data on th soil samples taken from this plantatio The soil reactions are uniform and in dicate that this soil was slightly acic Lime requirements on an acre basi varied from a minimum of 2,243 pound

Table 2

SOIL REACTION, AMOUNT OF NITRATE NITROGEN PRIOR TO INCUBATION AND FOLLOWING INCUBATION AISO TOTAL NITROGEN IN SOIL SAMPLES TAKEN FROM PLOT 1

	Soil (pH) reaction	Percent total nitrogen	Nitrate nitrogen prior to incubation	Nitrate nitrogen after incubatio
			Parts per million, air dr	
Black locust	5.63	.1463	8.2	75.3
Catalpa, sample from areas between 1st and 3rd rows	5.14	.1316	8.9	68.7
Catalpa, sample from area between 7th and 9th rows	5.74	.1263	1.8	36.9
Check. Oak woodlot, adjacent	5.49	.1575	2.0	52.6

r the sample with a p^H of 5.74 to 4,590 unds for the sample with a p^H of 5.14. Reynolds (16) states that nitrifying pacity is related to the total nitrogen the soil. This is the case in the pres- t study. The presence of black locust these soils has evidently resulted in creasing the total nitrogen content of e soil.

Since the total nitrogen is influenced the growth of black locust one would pect the nitrifying capacity of these ils to vary according to the total nitro- n, and also the growth measurements to ry accordingly. Chart 1 shows this to the case. These results are very pro- bunced in the case of the two soils udied even though the initial soil reac- ons are quite different. As would be ex- ected, where the soil reaction was p^{H7} r slightly over, as in the case of the erks soil, the maximum effects are und.

The manner in which the presence of lack locust has influenced catalpa grow- g adjacent is shown in Figure 1. It is vident that when catalpa is grown be- veen plots of black locust the growth nd nitrifying capacity is much larger, ecoming less as the distance from the lack locust increases.

In Table 3 are presented data obtained rom the studies in the 17-year-old plan- ation. The same relative values for tree rowth and soil samples were secured. he increased growth of catalpa when lanted in alternate rows with black ocust and where the six rows were ounded on both sides by black locust vas very evident. In both instances the iameter and height growth of catalpa pproximated that of the black locust nd the trees looked exceptionally vigor- us and healthy.

The six rows of catalpa occupied an rea approximately 44 feet wide; it seems vident that the roots of the locust must enetrate all through this strip of soil.

TABLE 3

EFFECT OF BLACK LOCUST ON CATALPA AND NITROGEN CONTENT OF SOIL

	Average diameter at breast height. Inches	Average total tree height. Feet	Basis, number of trees	Acidity (pH) value	Percentage total nitrogen	Nitrate nitrogen prior to incubation	Nitrate nitrogen after incubation
						Parts per million, air dry	
Black locust. Top of slope	5.5	43.3	93	7.17	.2469	19.7	86.6
Black locust. On slight bench	5.8	45.6	—	7.18	.2121	20.6	93.1
Catalpa. Intermediate six rows	5.7	41.5	74	7.51	.1780	9.7	69.4
Black locust. Lower slope	5.9	44.4	104	7.23	.2387	11.0	88.0
Catalpa. Bottom of slope. Sample from area between 3rd and 6th rows	4.1	33.4	—	7.51	.1748	5.5	50.6
Catalpa. Bottom of slope. Sample from area between 7th and 8th rows	3.6	28.0	40	7.42	.1529	6.4	41.6
Check. Oak woodlot, adjacent	—	—	—	7.27	.1575	2.6	52.6

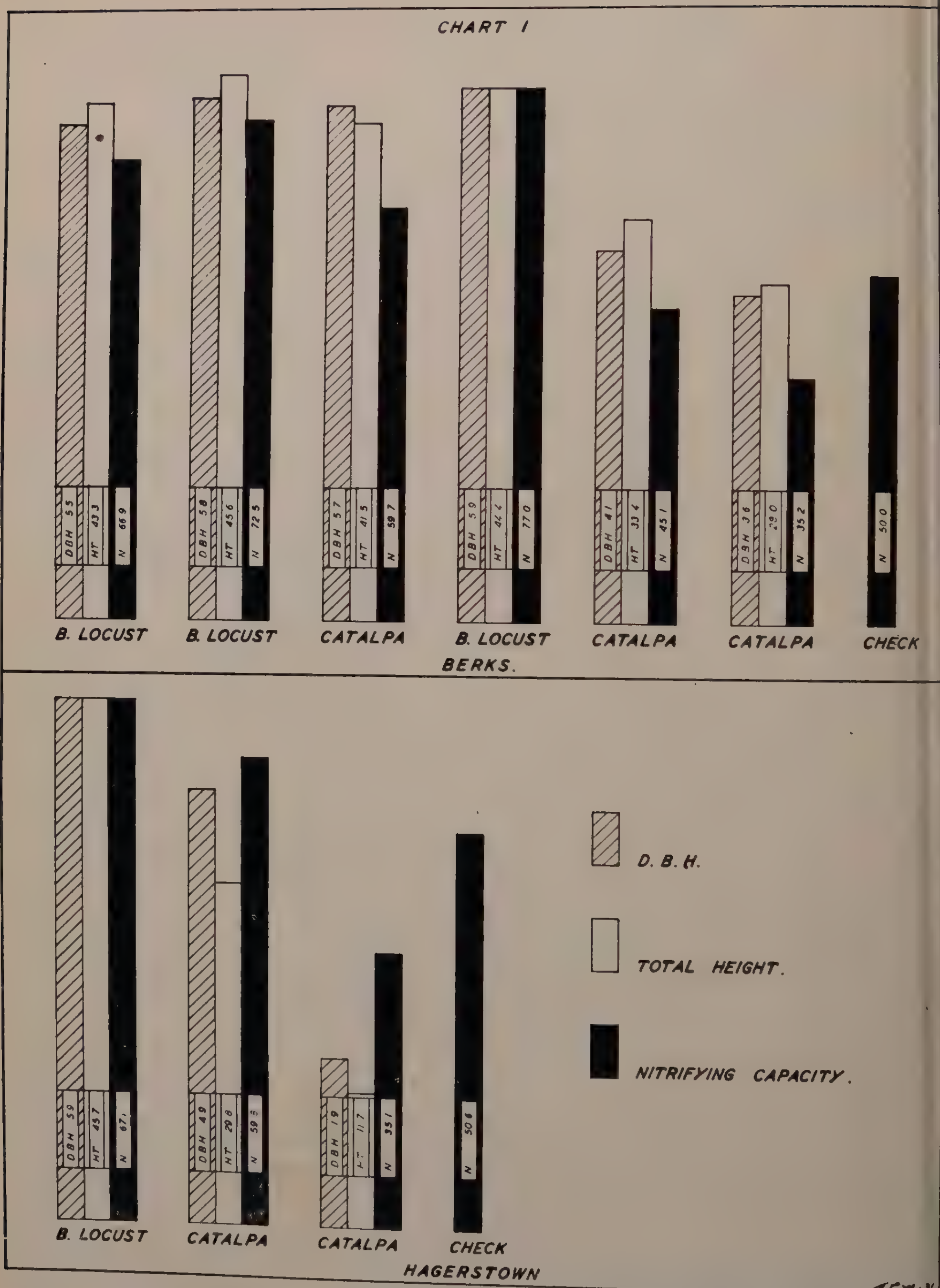

FIG. 1.—Influence of the presence of black locust upon the growth of adjacent catalpa.

this plantation, as well as in the other, oth the total nitrogen and nitrate nitrogen ccumulation values for the soil sample ken from under the catalpa adjacent to e locust are slightly lower than for the mples secured from under the black cust. This may be due to the catalpa aking use of the free nitrogen very pidly, but is probably also due to the ature of the litter and humus which ontributes to the soils fertility. For exmple it has been found that the leaf old from under black locust breaks own rapidly and apparently has a gher fertilizing value than other types f tree litter or leaf mold (9). Jashi 13) thinks that it is highly probable at the stem and roots of plants, espeally of legumes, serve as a source of nergy for nitrogen fixing bacteria, as zoto bacter, and so ultimately prove an ndirect source of nitrogen. Increased mounts of black locust litter directly nder the stand may thus be partially reponsible for the higher nitrogen values.

Application of Results

Foresters are beginning to think in erms of mixed planting. In this respect merican foresters are slightly behind uropeans, who have for years realized hat stands composed of both conifers nd broad-leaved species are more productive and maintain soil fertility.

Black locust is an excellent species to se in mixed plantings. It grows rapidly, ermitting an early thinning, and thus ecuring a marketable product, such as ence posts, bolts or mine material. The emand for locust will undoubtedly increase as its desirable properties become etter known and more material becomes vailable. The species is light foliaged, nd semi-light-tolerant species will grow n association with it. Will not the beneficial effects of increased soil fertility ompensate for the slight shade cast by he locust crown? The species is known to adapt itself to a wide variety of soil and site conditions and can be planted wherever any other hardwood species would be planted.

The planting of other species in mixture with black locust is advocated as a means of controling the locust borer (6). The seeds of black locust germinate readily and one-year-old seedling stock, which is the best size to plant, is easily grown. Because of its ability to fix nitrogen, the black locust enriches the soil on which it grows. This increased soil fertility aids in stimulating growth rate in associated species with greater assurance of stand establishment and development.

Conclusions

Certain tree species are larger when grown in association with black locust than when grown in pure stands or associated with other species. To measure the effect of this association, data were obtained on size of catalpa trees growing in mixture with or adjacent to black locust. Soil samples were taken and total nitrogen and nitrifying capacity values determined for the unit areas on which growth data were secured. The data show that black locust increases the total nitrogen ratio in the soil and thus materially increases the soil's fertility to aid the growth of catalpa.

Growth rate of catalpa and amount of nitrogen in the soil decreased as the distance from the adjacent black locust plantings increased. It is apparent that black locust contributes materially to soil fertility.

References

1. Allen, E. R., 1915. The determination of nitric nitrogen in soils Jour. of Ind. & Eng. Chem., Vol. 7, p. 521.
2. Allen, E. R., 1915. Reference-Zeit. Anal. Chem. 33:1894.

3. Alway, F. J., and Nyard L. J., 1928. Differentiation between acidity and lime deficiency in the case of peat soils. Pro. and Papers of the First Liter. Soils Congress. Comm. II. pp. 22-44.
4. Association of Official Agr. Chemists 1924. Official and tentative methods of analysis, p. 7. Published by the Association.
5. Beijerinek, M. W., 1918. The significance of the tubercle bacteria of the papilionaceae for the host plants. Proc. Royal Acad. Science Amsterdam 21: 183-192.
6. Craighead, F. C., 1919. Protection from the locust borer. U. S. D. A. Bul. 787.
7. Cope, J. A., 1929. Concerning black locust in New York. Journal of Forestry 27: 828.
8. Culbertson, G., 1914. Some preliminary investigations with regard to the cultivation of the black locust in southeastern Indiana. Indiana State Board of Forestry Fourteenth Annual Report, pages 67-72.
9. Dague, William F., 1928. Clearfield state forest tree nursery. Pa. Dept. of Forests and Waters. Bul. 47 pp. 12.
10. Duggar, R. M., 1920. Hydrogen ion concentration and the composition of nutrient solutions in relation to the growth of seed plants. Annal. Mo. Bot. Gas. Vol. 7, p. 1-49.
11. Ferguson, J. A., 1922. Influence of locust on the growth of catalpa Journal of Forestry 20: 318-31
12. Illick, J. S., 1925. Pennsylvani trees. Pa. Dept. of Forests an Waters. Bul. 11 pp. 187.
13. Jashi, N. V., 1919. Rate of nitrification of different green manure and parts of green manures an the influence of crop residers o nitrification. Agr'l. Jour. of India 14: 395-413.
14. Mattoon, W. R., 1930. Growin black locust trees. U. S. D. A Farmers Bul. 1628.
15. ———, 1930. Black locust. Jo of For. 28: 763.
16. Reynolds, E. B., 1931. A chemica and microbiological study of Lu kin fine sandy loam in relation t productiveness. Texas A. Exp. Sta tion Bul. 421.
17. Salter, R. M., and McIlvaine, F C., 1920. The effect of reaction o solution on the germination o seeds and growth of seedling Jour. of Ag. Res. Vol. 19, p. 73-9
18. Sudworth, George B., 1927. Check list of the forest trees of the Unite States; their names and range U. S. D. A. Mis. Cir. 92, pp. 16 172.
19. Truog, E., 1918. Soil acidity: It relation to the growth of plant Soil Cir. Vol. 5. pp. 169-195.
20. Waksman, S. A., 1923. Methods fo study of nitrification. Soil Scienc Vol. 15, pp. 241-260.
21. ———, 1929. Principles of soi microbiology, p. 733.

VARIATION IN CHARACTERISTICS OF BLACK LOCUST SEEDS FROM TWO REGIONS[1]

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The high technical qualities of the wood of black locust and the ease of growing the tree have caused this species to be planted in many parts of the world outside its originally restricted natural range in the eastern United States. It is a popular tree in the more arid regions of the West. Singularly enough, commercial seed used in America comes from foreign countries. Studies, like the one here reported, are therefore of interest and value in determining the suitability of home-grown seed.

BLACK LOCUST (*Robinia pseudacacia*, L.) is an important introduced tree species in Idaho much sed for woodlots and shelter belts. During the spring of 1929 about 160,000 ne-year-old seedlings of this species ere sent out to farmers of the state rom the nursery of the School of Forstry, at Moscow. In Idaho the demand or black locust seedlings is greater than or any other species and there are many ood reasons for this demand.

According to Gaskill (7) "Locust is, erhaps, our most valuable tree species hen rapidity of growth, adaptability to oil and climate, and qualities of wood re considered collectively." These same ualities of black locust are also summed p by Rogers (16). The locust borer (*Cyllene robiniae*) is the only serious nemy of this tree but it is causing no lamage west of central Colorado at the resent time.

Gaskill (7) says "Hungary has gone urther than any other country in planting black locust on a commercial scale." This species is also grown extensively n Austria and it is from that country and Hungary that the bulk of commercial seed is obtained. At least half of the commercial seed houses obtain their black locust seeds from Europe. In the United States most of the seed of this species is collected in the Southeast, but some is collected in western South Dakota and Colorado.

Object of the Study

The original purpose of this experiment was to confirm or disprove a belief that seed of black locust raised in Idaho has a lower germinative energy than imported black locust seeds. For planting in Idaho 1-0 seedlings are usually used and the seeds sown to produce them are purchased from the commercial seed houses.

Since, in the process of acclimitization, plants acquire certain characteristics which may be inherited there usually are some advantages in using home-grown seed for sowing. Working on this assumption Idaho and Austrian black locust seeds, treated in various ways, were compared to determine the germinative energy.

[1]A thesis presented in partial fulfilment of the requirements for the degree of Bachelor of Science n the School of Forestry of the University of Idaho.

[2]This study was carried out in the greenhouse of the School of Forestry of the University of daho. The writer wishes to thank Professor T. G. Taylor, Utah State Agriculture College, formerly ssistant Professor of Forestry at the University of Idaho, and Dr. F. W. Haasis, formerly Associate rofessor of Forestry, University of Idaho, now with the Carnegie Coastal Laboratory, for their oöperation and suggestions.

Previous Work

Considerable study has been given to the problem of retarded seed germination. According to Tillotson (17) black locust is among the trees whose seed is likely to lie dormant over a year before germinating. He suggests, as a method of hastening germination, to soak the seeds in water heated nearly to the boiling point and after they have swollen to plant the seeds at once, repeating the soaking for all seeds that do not swell the first time.

Durland and Toumey (5) studied the effect of soaking certain tree seeds. They say: "Black locust and many other leguminous species produce seed, which when sown in a dry condition often lie in the ground for months without germinating. When soaked in hot or tepid water for one or more days they germinate at once. Usually temperatures of from 5° to 10° F. below boiling are used for treating seeds."

Rogers (16) made studies to determine the advantages of scarifying hard coated seeds and both Uphof (20) and Minns (11) studied the effect of acids on germination. In some cases good results were obtained while other tests proved to be ineffective. Various other investigations have served as a background for the present study, but it is unnecessary to give specific summaries of the conclusions here. These reports are included in the bibliography appended to this paper.

Methods and Results

Local seeds were collected from 10 average trees in the Idaho School of Forestry Arboretum. These trees were 17 years old at the time the seed was collected (October, 1929), and they averaged about 40 feet in height and 6 inches in diameter, breast high. The seeds, pods and all, were stored in sacks in a cool dry room until threshed out in December by flailing the sacks. The seeds were the stored in small paraffined cardboard containers. The seed from Austria was store in the same way and all seeds kept in cool, dry place throughout the winte

During the month of March, 1929, th seeds from both sources were cleaned c all impurities as well as of shriveled an cracked seeds. One thousand seeds fron each region were weighed to the neare milligram and on this basis the number of seeds per pound was compute and found to be a little over 23,000 fo Austrian seed and 25,000 for Idaho seed These figures show the seeds from bot sources to be larger than those studie by Tillotson (17) who found about 27 000 seeds to the pound.

The seeds from Austria seemed a li tle more plump and darker in colo while seed coats of the Idaho seeds wer much the harder as determined by cu ting through them with a knife.

On April 15, 1929, 600 seeds from each source were immersed for about 1 minutes in a 0.25 per cent solution of th seed disinfectant "Semesan" to kill an bacteria and mould spores that might b present. It seems likely that the Semesa treatment did not appreciably affect th germinative energy of the seeds. Haasi (9) studies, in which pine and spruc seeds were soaked for an hour in a 0.2 per cent Semesan solution, indicate tha the disinfectant had practically no effec on the germinative energy. After thi treatment the seeds were sown in stean sterilized sandy-loam soil, and covere with sand from 1/8 to 3/16 of an inc deep.

The seeds were sown in rows about 4 to the foot and 100 seeds to the row Rows of Idaho and Austrian seeds wer alternated. The seed beds were watere every day throughout the germinatio period. The temperature fluctuated on a average between 60° F. at night and 75° F during the day. The relative humidity wa maintained at about 25 per cent by occa

ally sprinkling water about the green-se.

able 1 gives a record of the plants hey came up, the rows in the green-se having been laid out in the same tive positions as in the table. The et shows cumulative germination by ay periods for 33 days.

he germination of the 6 rows of ho seed was 23 per cent and for the trian seed 33 per cent. This differ-e was not great considering the varia- between the several rows.

t was decided to sow more seeds and pare various treatments which have n used by other investigators to stimu- germination. Hot water, scarifying, mbination of these two, and sulphuric treatments were tried. In addition ls dipped in Semesan solution were d as controls.

hree hundred seeds from each source e treated by each method. The seeds ted with hot water were placed in tin s and about a quart of water heated 170° F. was poured over them. This er was allowed to cool off to green-se temperature but the seeds were immersed for 22 hours before sowing. seeds that were scarified were chipped on one side with a sharp knife before sowing. Another lot of seeds from each source was chipped in this fashion and then treated with hot water, as in the case of the unscarified seeds, but with the water temperature 165° F. The seeds to be treated with sulphuric acid were placed in flat, glazed, porcelain dishes and steeped for 30 minutes in the concentrated acid. The seed coats faded from black to grey. After the treatment the acid was drained off and the seeds rinsed thoroughly in water.

These lots of 300 seeds from each source were sown, on May 18, in the same greenhouse and in the same manner as the seed sown on April 15th. The greenhouse temperatures varied less than during the earlier germination period, fluctuating between 60 degrees at night and 65 degrees during the day, except for three or four bright days when the temperature went up to about 75 degrees. The weather was cloudy nearly every day in great contrast to the bright days of the earlier period. Tables 2 and 3 show both the arrangement of the rows in the greenhouse and the germination results.

Only 21 days were required before im-

TABLE 1

ACCUMULATIVE GERMINATION OF SEEDS SOWN, 100 IN A ROW, APRIL 15, 1929

SEMESAN TREATMENT

Date	Day No.	Row number and source of seed: 1 I[1]	2 A[1]	3 I	4 A	5 I	6 A	7 I	8 A	9 I	10 A	11 I	12 A
April 20	5	1	0	3	0	1	0	0	1	0	0	1	0
22	7	8	0	8	1	11	0	10	2	6	1	5	4
24	9	8	0	10	1	14	5	10	7	6	8	5	18
26	11	10	1	11	5	16	11	10	11	6	13	5	19
28	13	12	4	15	17	18	17	10	28	10	30	5	28
30	15	18	4	21	18	23	17	12	28	15	30	6	29
May 2	17	19	4	21	21	27	18	13	28	20	31	6	32
4	19	20	6	21	29	27	24	13	32	20	33	6	36
6	21	23	14	21	30	28	25	13	33	20	33	6	39
8	23	25	18	23	31	28	27	13	37	22	35	6	40
10	25	26	19	23	33	28	28	13	38	22	35	7	40
12	27	28	19	24	33	29	28	13	38	22	35	7	42
14	29	32	19	25	33	29	28	16	38	23	35	10	42
16	31	32	19	25	33	31	29	16	38	23	35	13	42
18	33	32	19	25	33	31	29	16	38	23	35	13	42

[1]I, indicates Idaho seed; A, Austrian seed.

mediate germination ceased in this test while 33 days were required for the test started April 15th. At the same time the germinative energy of the Semesan treated Austrian seed dropped 10 per cent. These differences may be due to the higher average daily temperature during the earlier period, but probably in part due to variations in the samples of seed used.

Treating with hot water did not affect the Idaho seed but caused the germinative energy of the Austrian seed to be 51 per cent as compared to 23 per cent for the control. This is an increase of 122 per cent. Scarifying increased the germinative energy of seeds from both sources, but affected the Idaho seed the more. Scarifying and then subjecting the seed to hot water killed the kernels of both kinds. The acid treated seed was evidently subjected to the sulphuric acid too long as the germination was very low, especially with the Austrian seed.

The results show that the seed coats of the Idaho seeds are harder and more impermeable than the seed coats of the Austrian seeds and different methods of treatment are, therefore, necessary for best results. While soaking in hot water was the best treatment for the Austrian seeds it was not so for the harder coated Idaho seeds, which responded most fully to scarifying.

Summary

When Idaho and Austrian seeds were dipped in Semesan solution the germinative energy was 1 per cent and 10 per

Table 3

SUMMARY OF TOTAL GERMINATION PERCENTAGES

Treatement[1]	Idaho seeds	Austrian seeds
I	22	23
II	20	51
III	62	36
IV	1	0
V	17	1

[1]See Note 2, Table 2.

Table 2

SEED TREATMENT TEST

RESULTS IN TERMS OF CUMULATIVE GERMINATIVE PERCENTAGES

Seeds sown, 100 in a row, May 18, 1929

Date	Day No.	1 I	2 A	3 I	4 A	5 I	6 A	7 I	8 A	9 I	10 A	11 I	12 A	13 I	14 A	15 I	16 A	17 I	18 A	19 I	20 A	21 I	22 A	23 I	24 A	25 I	26 A	27 I	28 A	29 I	30 A
Methods of treatment[2]		I	I	II	II	III	III	IV	IV	V	V	I	I	II	II	III	III	IV	IV	V	V	I	I	II	II	III	III	IV	IV	V	V
May 22	4	0	1	2	7	5	9	0	0	3	1	0	1	1	7	5	1	0	0	0	0	2	0	5	6	5	6	0	0	4	0
24	6	4	11	15	57	38	31	0	0	8	1	10	5	16	39	55	27	0	0	6	0	4	7	9	36	44	29	1	0	17	0
25	7	5	15	15	57	38	32	0	0	8	1	12	7	16	42	61	30	0	0	12	1	6	8	10	37	51	33	1	0	17	0
27	9	8	17	18	60	52	35	0	0	10	1	16	10	18	44	67	32	1	0	13	1	14	22	10	39	51	36	1	0	17	1
29	11	12	17	18	62	52	35	0	0	11	1	19	13	18	44	69	34	1	0	14	1	18	22	12	40	57	36	1	0	21	1
31	13	13	18	19	64	52	35	0	0	13	1	19	14	21	48	70	34	1	0	14	1	24	28	12	42	59	37	1	0	21	1
June 2	15	15	19	19	64	52	35	0	0	13	1	19	15	21	48	70	35	1	0	15	1	26	28	13	42	63	37	1	0	22	1
4	17	18	23	21	64	53	35	0	0	13	1	21	16	21	48	70	35	1	0	15	1	27	28	15	42	63	37	1	0	23	1
6	19	18	23	22	64	53	35	0	0	13	1	21	17	21	48	71	35	1	0	16	1	27	28	16	42	63	37	1	0	23	1
8	21	18	23	22	64	53	35	0	0	13	1	21	17	21	48	71	35	1	0	16	1	27	28	16	42	63	37	1	0	23	1

nt greater for the Austrian seeds, in o separate tests, which averaged 28 r cent.

The effect of treating Idaho seed with t water was negligible while the same atment increased the germination of strian seed to 51 per cent.

Scarifying increased the germinative ergy of both Idaho and Austrian seed t the increase was much greater in aho seed which went to 62 per cent as npared with 36 per cent for Austrian d.

Scarifying and then treating with hot ter killed practically all the seeds.

Treating seeds with sulphuric acid was t found to be successful, although 17 r cent of the Idaho seeds survived it.

Apparently the best treatment for seeds lected in Idaho is not the best treatnt for seeds collected in Austria bease of the difference in hardness of the d coats. The best treatment for Idaho ds seems to be scarifying, while Ausan seed germination can apparently st be stimulated by hot water treatment.

References

Bates, C. G. 1927. Better seeds, better trees. Jour. For. 25: 130-144.

Bates, C. G. 1913. The technique of seed testing. Proc. Soc. Am. For. 8: 127-138.

Boerker, R. H. 1916. Ecological investigations upon the germination and early growth of forest trees. Nebraska Univ. studies 16: 1-89.

Craighead, F. C. 1919. Protection from the locust borer. U. S. D. A. Bull. 787.

Durland, W. D., and Toumey, J. W. 1923. Effect of soaking certain tree seeds. Jour. of For. 21: 369-375.

Eckbo, N. B. 1916. Importance of source of seed in forestation. Proc. Soc. Am. For. 11: 240-243.

Gaskill, Alfred. 1906. Growing locust in Hungary. For. Quar. 4: 106-111.

8. Gussow, H. T. 1920. Monograph of Robinia with special regard to its significance in forestry. Montouschek. Rev. of: Vades, Eugen. Bot. Abs. 3: Entry 2698.
9. Haasis, F. W. 1928. Germinative energy of lots of coniferous-tree seed. Plant Physiology 4: 365-412.
10. Kommerell, Elizabeth. 1927. Influence of light on seed germination. Bot. Gazette 84: 223-224.
11. Minns, L. A. 1922. Acid for hastening germination. Florists Exchange 50: 211-. 1920. Bot. Absts. 10: Entry 1097.
12. Show, S. B. 1917. Methods of hastening germination. Jour. of For. 15: 1003.
13. Show, S. B. 1918. The relation of germination in the greenhouse and nursery. Jour. of For. 16: 319-328.
14. Sparhawk, W. N. 1922. Ecological and phytogeographical problems of light. Forstwiss. Centralbl. 43: 327-345. 1921. Botanical Abstracts 11: Entry 3767.
15. Pearson, G. A. 1914. Influence of the origin of seed. Proc. Soc. Am. For. 9: 113-119.
16. Rogers, E. C. 1921. Studies in retarded germination. Jour. of For. 19: 51-57.
17. Tillotson, C. R. 1923. Growing and planting hardwood seedlings on the farm. U. S. D. A. Farmers Bull.
18. Toumey, J. W. 1916. The testing of forest seeds. Proc. Soc. Am. For. 11: 91-93.
19. Toumey, J. W. Seeding and planting. 90-176. John Wiley and Sons, Inc., New York.
20. Uphof, J. C. T. 1921. Influence of acid on germination. Recueil Trav. Bot. Neerland 17: 33-68. 1920. Biological Absts. 8: Entry 673.
21. Ziegler, E. A. 1915. Seed data on some secondary tree species. For. Quar. 13: 361-364.

RELATION OF FOREST SITE QUALITY TO NUMBER OF PLANT INDIVIDUALS PER UNIT AREA

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Good forest sites usually support fewer tree individuals than poor sites at a given age. But more shrubby and herbaceous individuals may occur on the good site than on the poor. The author discusses the possible reasons for these conditions.

FORESTERS have long recognized that poor sites usually support a larger number of tree individuals per unit area than good sites. It is the writer's purpose to discuss this generally recognized fact and to point out some relations between the number of individuals of shrubby and herbaceous vegetation and forest site quality. This paper is intended to serve only as an introduction to further studies into this interesting field.

In the present paper site is understood to mean the sum of the effective conditions under which a plant or plant community lives, Toumey (14). It is the equivalent of the habitat of the ecologist. Site quality is generally measured by the height growth of dominant trees in the stand.

Number of Tree Individuals

The number of tree individuals per unit area varies with the species concerned and with the climatic conditions of the region discussed. Within any essentially uniform climatic region and for any given species the number of individuals per unit area is dependent, first of all, on the age of the stand. As a stand increases in age the individual trees increase in height, diameter, and volume, and at the same time, due particularly to the increase in area and volume of crowns and roots, the number of individuals per unit area decreases. At any given age after competition begins, however, the number of individuals per unit area, of a giv species, varies with the quality of t site, being relatively high on poor sit and low on good sites. Table 1 clear illustrates this fact. This condition is n directly due to age, however, but to t larger size of the individuals on the go sites.

Table 1 does not furnish data co cerning the number of individual tre in stands older or younger than 40 yea but the same general relationship, *i.* a greater number of tree individuals poor sites than on good, holds in stan more than 40 years old. In connecti with this statement the reader is referr to the original sources of the data p sented in Table 1. In stands less th 40 years old (more particularly stan less than 20 years old), the relation b tween number of tree individuals a site quality is not so clear, but data hand would seem to indicate that in least some cases the above described re tionship exists in stands as young as years.

It seems probable that the situati noted above is generally reversed in you stands, *i.e.*, good sites generally supp more tree seedlings than poor sites. T may be due in part to the fact that young stands the trees are all small a competition has not yet become so sev and eliminative as in older stands. seems clear that *if the size of the indiv uals of a given species remains the sa good sites will generally support greater number per unit area than po*

ites. Leffelman and Hawley (9) secured ata on the number of individuals of trees nd woody shrubs in young stands on ood, medium and poor sites. These data re presented in Table 2. They show hat in the juvenile stage there are a reater number of individuals of both ees and shrubs on sites of good quality han on sites of poor quality. R. F. aylor[1] states that his studies of reprouction on cut-over western hemlock-Sitka pruce areas in Southeastern Alaska inicate a denser reproduction on good han on poor sites. Although good sites ppear generally to support a larger umber of trees per acre than poor sites, efore competition begins, there are exeptions.

Bates (1) suggests that reproduction n good sites in sections of the Rocky Mountains may be poor, due to restricted oot development and consequent suscepbility to damage by downward dessicaion of the surface soil during periods of rought, and that poor sites may support super-abundance of reproduction, due the fact that the half-starved seedlings oot deeply, and thus safely. Pearson 13) states that in the Southwest the oils on which seedlings are most numerus ofttimes are too shallow or too stony support a good stand of timber, wheres the deepest and most fertile soils, hich produce the heaviest yields once hey are well stocked, are often stocked elow their capacity because they are unavorable to the establishment of seedngs.

Toumey (14) has suggested that beause of slower branch development, forst stands (presumably past the juvenile tage) on poor sites have more tree inividuals than good sites. He also states hat the number of boles per unit area not directly correlated with the denity of the crown cover. Chapman (3) ates that fewer trees are able to mature

[1]In a personal letter, February 24, 1930.

TABLE 1

SHOWING FOR VARIOUS SPECIES NUMBER OF TREES PER ACRE ON SITES OF VARYING QUALITY

Species	Region	Size of trees included—inches D.B.H.	Age of stand—years	Number of trees per acre at site index indicated 40	50	60	70	80	90	100	120	Standard or classification age—years	Author
Western yellow pine	N. Idaho	all	40	1246	1117	995	867	751	643	548	403	100	Behre (1928)
Red spruce	Northeast	1+	40	3055	2130	1695	1440	—	—	—	—	65	Meyer (1929)
Loblolly pine	South	2+	40	—	—	585	435	345	290	255	205	50	Forest Exp. Sta. (1929)
Long leaf pine	South	2+	40	690	625	575	515	465	405	355	—	50	Forest Exp. Sta. (1929)

on good sites than on poor, because of the larger sizes and greater crown spread attained. Unquestionably size, particularly as it relates to crown and root spread, is an important influence.

It seems quite evident that rapid growth and establishment of early dominance by certain of the trees on good sites is of prime importance in accounting for the smaller number of individuals on those areas. On the better sites the growth conditions are so generally favorable that initial development of the trees is correspondingly rapid. Seedlings vary in their inherent capacity for rapid and vigorous growth. Due to the excellence of the growth conditions on good sites the inherent high capacity for rapid growth in certain seedlings is probably expressed most fully. These vigorous seedlings develop rapidly and soon overtop their neighbors; dominance is expressed early. Farrow (5) has emphasized the importance of rapid height growth in connection with success in competition. The initial advantage gained by the dominant seedlings is increased by the process of cumulation, Clements, *et. al.*, (4). With a slightly more extensive root system one tree is capable of securing more soil moisture and nutrients, thereby decreasing the supply available to its neighbors. The increased food supply of the dominant results in proportional increase in size of its organs. As stature and spread of top increase the dominant individual also reacts upon the light conditions, decreasing the intensity of the light which reaches its neighbor below. Each advantage gained by the dominant represents a corresponding disadvantage to the subordinate. Competition becomes eliminative in character. The final result is that good sites have relatively small numbers of individuals as compared with poor sites.

On poor sites, on the other hand, due to relatively poor growth conditions, development is slow and an early manifestation of dominance is lacking amon the individual seedlings which continu to develop at a more or less unifor rate; differentiation into crown classe is delayed. It follows that no trees ar able to gain a decided advantage ove their neighbors; they all lack the stimulu to dominance furnished on the goo sites by the excellent growth condition Crowns develop more slowly and compe tition is not as eliminative as on goo sites.

Number of Shrubby and Herbaceous Individuals

The relation between the trees in forest stand and the shrubby and her baceous vegetation on the forest floor is in the case of some species, one of com petition; in many cases, however, th relationship is undoubtedly one of de pendence, Yapp (15). In other word the more tolerant shrubby and herba ceous elements are not in active compet tion with the dominant trees but are, t a large extent, dependent upon them fo existence. The forest may be considere a retreat to which dependent shrubby an herbaceous species retire because the are, for the most part, unable to develo on exposed sites.

Data collected by Hicock, *et. al.*, (8) and presented in Table 3, indicates th number of individuals of shrubby an herbaceous species on seven different so types in central Connecticut. It is ev

Table 2

REPRODUCTION FOUR YEARS AFTER CUTTING A 75 YEAR OLD MIXED OAK STAND[1]

Kind of vegetation	Quality of site		
	I	II	III
	Number per acre		
Trees	11399	8674	4292
Woody shrubs[2]	5314	2922	782

[1]Data from Leffelman and Hawley (9).

[2]*Viburnum acerifolium, Corylus* sp., *Hamameli virginiana*

nt that the better soils (Whitman loam d Peru loam soils) support larger mbers of individuals per unit area n the poorer sites (Hinsdale loam, oucester loam, Gloucester fine sandy m, Hinsdale fine sandy loam, and ddam fine sandy loam soils). This ation is in agreement with that noted trees before the competitive stage is ched but is the reverse of that exist- ; in tree growth after competition be- s. It seems clear that in the absence eliminative competition good sites sup- rt larger numbers of herb and shrub lividuals than poor sites, providing t the individuals are of about the ne size in both cases.

It may be suggested that competition ween the elements in the lower forest ers (shrubs, herbs, and tree seedlings) not so keen as the competition between elements in the upper forest layers ominant trees). This is probably due part to differences in the relative sea- al demands made upon the site by various shrubby and herbaceous spe- s. The relative seasonal demands of ubby and herbaceous species probably y more than the demands of the domi- nt tree vegetation. It seems to be fun- nental that severity of competition be- en individuals will vary inversely h the degree of difference in the de- nds which they make upon the site. Another factor in explaining the larger nber of shrubby and herbaceous in- iduals (and tree seedlings) on good s may be the more favorable carbon xide relations, particularly in the er air levels of the forest, Lunde- dh (10) and Meinecke (11). Fehér Sommer (6) point out the impor- ce of the carbon dioxide concentration forest air for the vegetation develop- on the forest floor. Under the protec- of the dominant trees the lesser etation develops in the carbon dioxide ched lower air strata; the increased concentration definitely stimulates growth, particularly on good sites.

Summary

At any given age, after competition begins, good forest sites usually support a smaller number of tree individuals per unit area than poor sites. Larger size, early expression of dominance, and eliminative competition largely account for the relatively small number of individuals on good sites; the reverse conditions for the relatively large number on poor sites. Until competition begins, due to more favorable growth conditions and practical uniformity of size, good sites as a rule support larger numbers of tree seedlings per unit area than poor sites. There are exceptions to this rule.

On good sites there appears to be a larger number of shrubby and herbaceous individuals per unit area than on poor sites. This is in agreement with the situation as regards number of tree seedlings before the competitive stage is reached but the reverse of the situation as regards numbers of tree individuals in stands that have reached the competitive stage. Eliminative competition is a very important factor in determining the number of plant individuals on any site; competition is probably not as great in the lesser

Table 3

AVERAGE NUMBER OF SHRUBBY AND HERBACEOUS INDIVIDUALS ON SOILS OF VARYING SITE QUALITY[1]

(Middle-aged, mixed hardwood stands, Central Connecticut.)

Soil type	Average number of individuals per square meter
(Relatively good sites)	
Whitman loam	88
Peru loam	70
(Relatively poor sites)	
Hinsdale loam	48
Gloucester loam	52
Gloucester fine sandy loam	54
Hinsdale fine sandy loam	41
Haddam fine sandy loam	46

[1]Data from Hicock, *et al*, (8).

vegetation as in the major vegetation, due to differences in the relative seasonal demands which the shrubs and herbs make upon the site. The larger number of shrubs and herbs on good than on poor sites is probably due to the larger supplies of food and moisture, and to the relatively high concentration of carbon dioxide in the lower air strata of the forest on good sites.

References

1. Bates, C. G. 1926. Some relations of plant ecology to silvicultural practice. Ecology 7: 469-480.
2. Behre, C. E. 1928. Preliminary normal yield tables for second-growth western yellow pine in northern Idaho and adjacent areas. Jour. Agr. Res. 37: 379-397.
3. Chapman, H. H. 1924. Forest mensuration. Second ed. revised. Wiley & Sons, N. Y.
4. Clements, F. E., Weaver, J. E., and Hanson, H. C. 1929. Plant competition, an analysis of community functions. Carnegie Institution of Washington Pub. 398.
5. Farrow, E. P. 1917. On the ecology of the vegetation of Breckland. Part V. Observations relating to competition between plants. Jour. of Ecology 5: 155-172.
6. Fehér, Dániel és Sommer, Geza. 1928. Vizsgálatok az erdőtalaj lélekzéseről kűlőnős tekintettel annák az erdő életében elfoglalt biologiai szerepére és gazdasági jelentőségére. [Researches on the carbon nutrition of the forest.] (English summary p. 292-305.) Erdészeti Kisérletek 30: 231-268. (Quoted from Biol. Abstr 4: 512-513. 1930.)
7. Forest Experiment Stations, Office of 1929. Volume, yield, and stand tables for second-growth southern pines U. S. Dept. Agr. Misc. Pub. 50.
8. Hicock, H. W., Morgan, M. F., Lutz H. J., Bull, Henry, and Lunt, H. A 1931. The relation of forest composition and rate of growth to certain soil characters. Conn. Agr. Exp Station (New Haven) Bull. 330.
9. Leffelman, L. J., and Hawley, R. C 1925. Studies of Connecticut hard woods. The treatment of advance growth arising as a result of thinnings and shelterwood cuttings. Yal University: School of Forestry. Bull 15.
10. Lundegardh, Henrik. 1927. Carbon dioxide evolution of soil and crop growth. Soil Science 23: 417-454.
11. Meinecke, Th. 1927. Die Kohlenstof fernährung des Waldes. J. Springer Berlin.
12. Meyer, W. H. 1929. Yields of second growth spruce and fir in the North east. U. S. Dept. Agr. Tech. Bull 142.
13. Pearson, G. A. 1923. Natural reproduction of western yellow pine i the Southwest. U. S. Dept. Agr. Bull 1105.
14. Toumey, J. W. 1928. Foundations o silviculture upon an ecological basis Wiley & Sons. N. Y.
15. Yapp, R. H. 1925. The inter-relation of plants in vegetation, and the con cept of the "association." Festschrift Carl Schrőter. Veröffentlichungen d Geobotanischen Institutes Rűbel i Zűrich. 3 Heft. S. 684-706.

A NEW PRINCIPLE IN SEED COLLECTING FOR NORWAY PINE
A CRITICISM

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The author, a forester and geneticist, presents an analytical criticism of the proof of the principle or law that was set forth and expounded by Mr. C. G. Bates[1] in an article on the source of seed appearing in the May 1931 issue of this Journal. He feels that Mr. Bates' conclusions lack validity because the experimental method used was defective and because the data do not sustain the hypothesis. Although it is not specifically stated and enlarged upon, the importance of considering the rôle of heredity when planning and conducting source-of-seed investigations is implied in the criticism.

THE ARTICLE, *A New Principle in Seed Collecting for Norway Pine* by C. G. Bates, of the Lake States Forest Experiment Station, which appeared recently in the Journal of Forestry (Vol. 29, No. 5, pp. 661-678), presents and defends the hypothesis that ". . . the strength of Norway pine (*Pinus resinosa* Ait.) seeds and the immediate vigor and hardiness of seedlings developing therefrom vary inversely as the vegetative vigor of the parent trees," and that (to quote the author further) ". . . the strong produce the weak and the weak produce the strong progeny, at least in the sense of early survival." The title of the paper intimates that the hypothesis has been proved and therefore, that it is an established principle. The utility of the principle consists, in part at least, of its efficacy as a guide to nurserymen in collecting superior Norway pine seed. It appears to me, however, that the demonstration and proof of the thesis is vulnerable to major criticism at several places, and, inasmuch as the author's conclusions—coming, as they do, from an agency that deservedly possesses the confidence and respect of the public—may influence and affect commercial practices unfavorably, it seems proper, if they are erroneous, overreaching or premature, that they be challenged lest unwarrented reliance be placed on them.

Briefly, two major defects deserve to be noticed; *viz.*, (1) the experimental method that was used by the author to prove the theory was such that it could not accommodate properly such an investigation, and (2) the data do not sustain the hypothesis.

The general meaning of the theory is understood; but, since the author's demonstration omits a detailed consideration of quantity production, there is some ambiguity about the meaning of "vigor" and "hardiness." "Strength of seed" obviously refers to germinative force, and, unless "vigor" and "hardiness" are used synonomously, "vigor" of both mother-tree and progeny should relate to quantitative production; "hardiness" has reference to ability to endure freezing, as well as to survival of seedlings. If this be correct, the assertion of the hypothesis regarding these three quantitative characters must be upheld and defended by the results of adequate tests, the data from which cannot give strong support to any other plausible explanation, before the theory can be elevated to the dignity of a principle.

[1]This criticism was submitted to Mr. Bates, who elects to make no rebuttal, but comments—"I prefer to let time justify my judgment in presenting the facts and conclusions as I see them."—*Ed.*

The Experimental Method

The hypothesis asserts three negative correlations. These relationships, if they exist, must be caught and reflected by the data which constitute, as it were, a mirror held up to nature by the investigator. They must be obvious or indistinct. If they are obvious, the seeds from the non-vegetative trees will have consistently good records, and those from the vegetative trees will have uniformly poor records; whence we may forthwith conclude —providing the samples are representative—that the data constitute, as it were, the voice of a Polydoras warning the seed-collector away from the vegetative trees. If they are indistinct, a more involved method of correlation analysis must be employed to reveal them.

The author employs the method of comparing types, but since the comparisons are not attended and served by complete statistical analyses or the results thereof, it may be inferred that the relationships are considered to be ostensive in the data. And, in truth, a hasty or careless examination of his Table 2 might suggest as much. It seems to me that the method was defective in design and execution—but, perhaps, less in the former than in the latter—because the following deficiencies are observable, *viz.*, the characterizations of the parent trees, based as they are mostly on ocular inspections rather than accurate measurements, are very indefinite (hence it is impossible to sift and segregate the various lots definitely into vegetative and non-vegetative categories for the purpose of making equitable comparisons), essential data are lacking or they are too meagre to serve the purpose, the results were not sufficiently confirmed, and the analytical methods used in evaluating the data leave much to be desired.

It might be inferred from a superficial examination of Table 2 (the title of which is misleading because lots 13, 21, and 24, which are noted by the author as being from non-vegetative trees, are included in the vegetative series) that with regard to hardiness, the correlation is partially indicated because the non-vegetative group contains lots having generally good records in "seedling survival per cent" and "production from seed per cent," whereas the vegetative series is composed, for the most part, of lots having consistently poor records in those respects. But more careful study and analysis will indicate that such a conclusion is not authorized by the data.

The vegetative *appearance* of the trees was the criterion used in classifying most of the twenty-five lots (only twenty-five of the forty-one lots are definitely distinguished by the author in his discussion). It was given no definite numerical value; hence the designations are not definite, but vague. This may be illustrated by the author's manipulation of the lots. Thus, Lots 20, 21, and 23 of Group 1 in Table 1 are referred to and described on pages 665-668 as being ". . . from fairly old unthrifty trees" . . . etc. But in Table 2, Lot 21 is included in the vegetative series. And in Group 2 of Table 1, Lots 13 and 24 are noted on pages 672-673 as being of the non-vegetative type; yet in Table 2 they are classed as vegetative lots. Nothing is known about the vegetative vigor of Lots 80 and 81. Lot 80 "represents a group of four old trees," and Lot 81 is from ". . . three comparitively young" . . . etc., trees; whence there may be some justification for the deduction that Lot 80 is less vegetative than Lot 81; but it hardly satisfies scientific requirements. In short, the author's characterizations are seldom definite and positive; and so it is impossible to separate the various lots definitely into distinctly different categories. Therefore we cannot make an adequate comparison of the types; hence, it is impossible to detect and identify the correlations by observation alone because in both vigor-

ypes all the characters involved are amped by great variation. We are justi- ed then, in concluding that the relation- hips are not obvious, and that, if they xist, they must be unfolded by a more ivolved method of statistical analysis. Norway pine is a partially cross-fertil- zed tree; so that theoretically there is kely to be a great amount of variation 1 the expression of any quantitative char- cter because of the influence and effect f heredity alone. Beyond stating that esemblances and variations inhabit and haracterize a species of tree, and hence, hat the laws of genetics apply as well to rees as to cats, dogs, fruit flies, corn, uman beings, etc., I will not attempt to rove the statement; but the discussion hat follows regarding Lots 34 and 35 nay strongly suggest as much.

Referring to the basic data in Table and following the author's discussion, is at once apparent that the supposedly ypical Lots 34 and 35 present some in- olved problems. The data of the per- ormances of these lots, as well as the hotographs and statistics of the parent rees, are most interesting from a gene- ical as well as a physiological point of iew. The following table shows the essen- ial facts regarding the mother-trees 34 nd 35.

It would seem that Tree 35, although haracterized as non-vegetative, might be nore vigorous inherently than the so- alled vegetative Tree 34; for, although t is two years younger, is growing on poorer site, has been, and still is, ubjected to greater competition, and ap- ears to be less vigorous than Tree 34, it has excelled the latter in height-growth and has equalled, if not outdistanced, it in quantity production. The small differ- ence in diameter may be attributed to the fact that it is younger than Tree 34, as well as to the greater competition it has encountered. Now, if Tree 35 is actu- ally non-vegetative, and if its lack of vigor is the sole or specific cause of the superior record of its progeny with re- gard to any character, it must have been non-vegetative for at least one year and probably for two years or more. In short, Tree 35 has given Tree 34 (figura- tively speaking) a handicap of two years in age, a better site, less competition and, if the hypothesis be true, one year or more of poor health to boot, and still has surpassed, or at least has equalled it in quantity production—a remarkable per- formance for a permanently non-vegeta- tive tree, and a very creditable one for a tree which has been crippled and sup- pressed by adversity for just a few years. May there not be an inherent difference in the vigor and vitality of these trees? It would be interesting and instructive to see a boring from each. If a boring from Tree 35 should show that there has been no sudden abatement in rate of growth, ought we not to conclude that this tree always has had a non-vegetative appearance and that its crown, although thin, is inherently very efficient?

The data then, as well as theoretical considerations, would seem to suggest that the vigor of trees is affected by hereditary influences. If this be so, may we not infer that hereditary factors will cause or force trees of the same vigor to

	Tree 34	Tree 35
Apparent vegetative vigor	More vigorous	Less vigorous
Age, in years	48	46
Height, in feet	45	50
D.b.h., in inches	14.0	12.5
Site	Better	Poorer
Competition, past and present	Less	More

be fundamentally different, so that all vegetative (or non-vegetative) trees should not be expected to produce progeny of the same stamp in so far as the expression of quantitative characters is concerned?

On the other hand, the expression of quantitative characters is affected also by environmental conditions and age; so that heredity and environment possess parallel properties and are thus enabled to masquerade quite freely as the same causative agent to the embarrassment of the spectator. This may be illustrated by the enigma which the theory and the tree and progeny records of Trees 34 and 35 present.

If it be possible, as the hypothesis implies, to perceive the quality of the progenies in the appearance of the parents, we should behold the visages of the latter in the performance of the former. But, if the vigor and vegetative aspect of Trees 34 and 35 were to be judged by the records of the progenies, there would be ample justification for regarding them as being practically equal vegetatively because, although the progeny of Tree 35 holds a doubtful advantage in hardiness as measured by inurement to freezing, it is inferior in strength of seed and possesses no advantage in hardiness as measured by production from seed (survival). The relative vigor of the progenies—and hence of the parent trees—cannot be discerned because the necessary data are lacking. But as the photograph on page 669 shows, the trees differ greatly in appearance; so that if Tree 34 is, as the author states, the more vigorous, and if vegetative vigor is inimical to the production of superior progeny, some factor other than real or apparent vigor has operated in Tree 34 to elevate its progeny to the level of the progeny of the less vegetative Tree 35, or in Tree 35 to abase its progeny to the standard of Tree 34, or in each to effect an equalization. If this be well considered, and if the testimony of one outstanding example be admitted, must we not conclude that differences in genetical constitutions may act to neutralize as well as to accentuate the effects of environment and age? And so it is impossible to perceive in the data where the influence and effect of heredity on the expression of quantitative characters ends and that of environment begins, or vice versa.

For the purpose of the experiment, therefore, inherent differences should be eliminated by using trees that are homozygous for the characters that are to be tested, or the samples from which the data are to be obtained must be very large, indeed (at least sufficiently large to be representative; that is, to yield reliable information about the amount of variation that accompanies the various characters). In either instance, as a matter of fact, the samples might well be larger than are those that were obtained for this investigation. Now, since it cannot be said that the influence of heredity was eliminated, the collection of eight or ten trees for a sample—as was done with regard to the vegetative lots—may be likened to a cruise along the coast without making any excursions inland to explore the country; and, just as such a cursory survey can hardly recruit enough information for an accurate description of the region, so is it to be doubted that reliable inferences regarding the correlation of quantitative characters can be drawn from the performances of the progenies of such a small and indefinitely characterized sample of a partially cross-fertilized population.

The foregoing applies generally; specifically, there are insufficient data on the "top weight of seedlings" and on the effects of freezing to accommodate a determination of the presence or absence of the correlations involved.

It is realized and appreciated that this investigation arose incidentally and that if possible, the data that were obtained

d made available should be used; but, though it may not be necessary to inst on the observance of austere biometril precepts in such work, there neverthess is a limit to the indulgence and edit that can logically be extended to sufficient data, urgent and exceptional the need may be; for such data are nerally as unmanageable as a ship ithout a rudder, which, if driven, may to any but the desired goal. With rerd to the data then, we must set down ifficiency as another desideratum.

It is almost axiomatic among workers the biological sciences that an unrified result is, like rumor, lacking in ustworthiness. Upon the arrival of mor, prudent people defend themselves gainst error by suspending judgment ntil confirmation not only effects a lusation of the news but also renders cerin what was doubtful. And this excelnt rule of action, arising from universal xperience, is wisely adopted by scientsts; for, although it may be argued that me is lost by delay, haste made slowly —as the ancient fable of the hare and the rtoise aptly illustrates—is often safer nd more productive of reward than preipitate action based upon incomplete or nisleading information; whence, in the ng run, nothing actually is lost, but afety and assurance are gained by rearding the initial results of investigaons as the rumors of nature. Now, of ourse, the observance of this precept annot be a mandatory requirement beause a thing may be so whether it be onfirmed or not; but unverified expeririental results are by tacit agreement genrally regarded as being deficient in reiability. Therefore, the author's procelure may well be questioned, if not conlemned, because it failed to provide several annual confirmations of the result.

In explaining data and fitting an hyoothesis, scientists have wisely copied the nethod of tailors who, in making apparel or a customer, first take the customer's measurements accurately so that the clothes will fit well. So in explaining data, investigators are wont to measure them well, using suitable methods of statistical analysis and not depending on a cursory examination by eye, so that the explanation or hypothesis may fit the facts snugly. But it would seem that the author deviated from this excellent custom and measured the data in his Table 2 carelessly because, although in "Nursery germination per cent," "Seedling survival per cent" and "Production from seed per cent" the differences between the *averages* of the two types are large, there is among the members of each type *sufficient variation* in the characters mentioned to render doubtful, without further analysis, the statistical significance of each of the differences. The author does not present an adequate statistical comparison (or the results thereof) of the two types, but depends wholly upon the magnitude of the differences between the averages for proof that his conclusions are correct. But despite their magnitude, the differences are not clearly significant; and, therefore, the author's inferences and conclusions are not well justified in the scientific sense. The analysis of the data, then, was deficient in that the facts were not accurately gauged; and since this is a serious fault, we must make a scruple of it and hold the data for another trial and set aside the verdict for correction.

Inasmuch as the correlations that are enumerated in the hypothesis are not apparent in the data, and since the vegetative vigor of the various lots is not expressed numerically, comparisons must be used in proving the theory. This is a legitimate procedure because, if the comparisons are made properly and enough of them are made, the results will indicate the presence or absence of correlations, though not the amount thereof. But it seems to me that the author's use of that method leaves much to be desired; first, because only one comparison (of

two small groups) was made, and second, because the vegetative series in Table 2 hardly does justice to the vegetative type. Thus, although Lot 21 represents a more vegetative tree than does the other member of the pair, Lot 20, still Lot 22 (according to the author's description) is from a tree which is more vegetative than Lot 21; and, since its record is better than that of Lot 21 in "Nursery germination per cent," "Seedling survival per cent," and "Production from seed per cent," it cannot be said that the inclusion of Lot 21 in the vegetative group does the vegetative type full justice; but the inclusion of Lot 20 in the non-vegetative group is not prejudicial to the non-vegetative type. Likewise, Lot 61 is from a more vegetative tree than is Lot 60; but Lot 64 represents a more vegetative tree than does Lot 61; and, since its record is better than that of Lot 61, it cannot be said that the inclusion of Lot 61 in the vegetative group does full justice to the vegetative type, whereas the inclusion of Lot 60 in the non-vegetative series does that type ample justice. Moreover, there is hardly ample and legitimate justification for placing Lots 80 and 81 in either category because nothing is known about the vigor of either. In short, the grouping into series seems not to have been done equitably because (although, with the exception of Lots 80 and 81, about which nothing germane to the relative vigor of the trees is known, all of the lots in the vegetative group represent trees that are more vigorous than are the trees represented by the lots in the non-vegetative group) trees with excellent records, for the most part, were evidently selected for the non-vegetative group, whereas a similar method was not adhered to, where it was possible to do so, in selecting the trees for the vegetative series. Therefore, it may be said that the comparisons of the types are infected with a kind of bias; and so in still another respect, the analytical method was defective. So much, then, for the exper mental method.

The Data

If the data would substantiate the hy pothesis, they must show that the streng of Norway pine seed and the immedia vigor and hardiness of the seedling d veloping therefrom vary inversely as th vegetative vigor of the parent trees.

The author submits no data or com parison to prove that the correlation ex ists with regard to immediate vigor. Th data for "top-weight" of seedlings ar too meagre to accommodate a compar son; hence there is no column for tha character in Table 2.

The justification for using the resul of the freezing-tests in supporting th hypothesis may well be questioned. Th data are exceedingly meagre, and th results show little consistency; moreove the samples used were too small, and, i many instances, the tests were not dupl cated. Thus, the freezing test of Lot 7 consisted of subjecting two seedlings t the treatment; three trees were used fo Lot 81, and so on. In such heterozygou material as Norway pine (although per haps less heterozygous than most pines the variation in a particular quantitativ character cannot be determined reliabl from one small sample of two or thre seedlings. Furthermore, Table 2 contain no comparison of freezing tests, an hence, insofar as inurement to freezin is concerned, it has not been demon strated that in immediate hardiness th progenies of non-vegetative trees surpas those of vegetative trees.

Table 2 is presented to show, chiefly that in strength of seed (as measured b nursery germination), and in hardines (as measured by survival), the non-vege tative trees produce seed that are super ior to the seed produced by vegetativ trees. The three columns on the right o the table are submitted in proof thereo

ause in those respects the differences ween the averages are in favor of the ı-vegetative type.

Seedling survival per cent" and "Pro- tion from seed per cent" relate in a y to the character "hardiness." "Nurs- germination per cent" has reference "strength of seed." The other six col- ns may be ignored because the differ- es between the averages are much too all to be significant or they are in or of the vegetative type. Although differences between the (three) aver- s under consideration in each group in favor of the non-vegetative type, it unsafe to regard them as significant hout subjecting the data to a statistical alysis because the variation in the ns that make up the series is so great. us, for example, the average nursery mination per cent of the non-vegeta- e type, which is 57.1, is made up of ividual lot-figures ranging from 18.1 77.6.

The proof of the hypothesis with regard to "hardiness" of the seedlings depends upon the results of the freezing tests and the results of the comparisons of "Seedling survival per cent" and "Production from seed per cent." The results of the freezing tests are, as has been shown, only suggestive because they supply merely evidence which is doubtful, and not clear proof. The comparison of the two series with regard to hardiness (as measured by two forms of survival figures) gives results that, without further tests, leave the matter undetermined because the odds, 39.2:1 and 27.7:1, do not indicate clearly that the differences in favor of the non-vegetative series are statistically significant. One is above and the other below 30:1; and, inasmuch as the comparison is stained with a sort of bias, and since the results have not been confirmed, it is well to regard the odds as standing in the border-zone of significance, indicating that judg-

mparison	Odds	Significance of difference
rsery germination per cent	2.65:1	Not significant
edling survival per cent	39.2 :1	On the border-line
oduction from seed per cent	27.7 :1	On the border-line

The table above gives the results of ee statistical comparisons of the two es, made by using Love's Modification Student's Method:[2]

It is customary to regard the difference tween two averages as significant if the ds are 30:1 or greater. Odds if less an 30:1 indicate that the difference is t significant.

The results show clearly that the data not sustain the hypothesis with regard strength of seed. We have seen that data are presented to prove that the edlings of the non-vegetative trees are ore vigorous; so that, certainly, two rds of the hypothesis are not sustained the data.

ment should be deferred until further and more convincing testimony can be had from nature.

Now, since the differences are not significant, the comparisons fail to prove that the correlation set forth in the hypothesis exists; hence all of the assertions of the hypothesis want proof; and so in the scientific sense, the title of the article really constitutes an hypothesis in disguise and should not be esteemed as a demonstrated principle.

The statement on page 661 that "Whether inhibition of vegetative vigor in the parent trees comes as a result of advanced age, competition of other trees, poor soil, lack of moisture, deterioration

[2] Love, H. H., a modification of student's table for use in interpreting experimental results. Amer. c. Agron. Journal 16:68-73. 1924.

of the soil (usually accompanied at least by stem injury), or other injuries such as root curtailment, it will generally be found that the seed produced by slow-growing trees is of an entirely different physical quality, better-filled and nourished, and superior in every way to that from very vigorous trees," constitutes, as it were, a supplement to the hypothesis which rounds it out and renders it more complete. But, in view of the fact that no data are mustered to prove that such seed ". . . is of an entirely different physical quality, better-filled and nourished" . . . etc., (for the data in Table 2 do not indicate as much), the statement sets forth a dangerous doctrine because, regardless of whether it arises from inference or deduction, it has, so far as we know, no firm foundation in fact. All of the factors—and they are legion—that can check or retard the vegetative vi of the tree may possibly produce same physiological reaction; but t they do so must still be proved. In absence of convincing evidence, it see to me more logical to conclude that effect on the expression of quantitat characters of decreasing or increas vegetative vigor will be according to physiological reaction of the particu tree to the particular condition; and si both conditions and trees (the latter herently) may vary infinitely, it see improbable that uniform effects will sult from the action of unlike agen (for example, all the conditions that retard vegetative vigor) on different c stitutions. But enough of theorizing; the purpose of this criticism is not disprove the hypothesis, but merely show that it has not been proved.

"The less Forest-Trees are pruned the better, particularly Pines and Firs. never suffered any to undergo that operation, except when the stem became forke in that case, the best shoot was preserved, and all others cut off close to the ster with such side-branches as were too strong, and drew so much sap from the root to prevent it properly expanding for the greater encrease of nourishment to enlar the trunk of the tree; the best soil for trees is where the Hazel grows well. I do n depend so much on the richness of the soil for trees as gardeners commonly do, havi observed most trees grow well in sheltered situations, and even on rocks."

A Treatise on Forest Trees, by William Boutcher, Dublin, 1784.

METHODS OF DETERMINING INCREMENT OVER LARGE AREAS

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The author describes, in this article, the methods employed in securing growth data for three counties of North Carolina; the methods used involve the application of yield tables to the areas examined and the measurement of increment on individual trees; the two methods are compared and a means is suggested for correcting the shortcomings of both.

PERHAPS ONE of the forester's most perplexing problems is that of securing growth data which can be made to apply over large areas, especially when time is a limiting element and when a figure better than a mere guess is needed. This problem presented itself to the Forest Taxation Inquiry when it desired to secure a growth figure for each of three counties studied in North Carolina for the purposes of comparing taxes levied on forest property with timber growth, and for testing out various systems of taxing forests. The counties studied were Beaufort, with a total area of 538,000 acres; Chatham, with 445,000 acres; and Macon, with 328,000 acres; an aggregate of 1,311,000 acres. This was a subordinate project to be carried out in conjunction with two other major field projects; namely, a check on the land classification made in each county by the assessors in 1927, and a verification of considerations paid in recent transfers of property as a basis for an assessment ratio study. The time alloted to these three projects was approximately thirty days in each county.

The methods used in this extensive growth determination were worked out in a coöperative arrangement between the Forest Taxation Inquiry, the Appalachian Forest Experiment Station, and the Southern Forest Experiment Station. It may be seen that it was impossible to make a detailed examination of such a large area in so short a time, and that the most accurate short cut possible had to be devised. While the methods developed are admittedly very rough, they are believed to be fairly accurate and are presented here to show the different results which may be obtained by using two different methods, and to suggest a means of correcting the shortcomings of both.

Yield Table Method

The two eastern counties (Beaufort, representing the Coastal Plain Region, and Chatham, the Piedmont) were found to be similar in one respect; they are both characterized by large areas of even-aged second-growth pine, which has sprung up on old fields or subsequent to logging or fire. On each forest tract there were more or less distinct areas occupied by a single 10-year age class. Some stands, however, had advanced growth left on them after a logging operation, and were, therefore, uneven-aged. On such areas, however, there were usually represented two, or probably more, very distinct 10-year age classes, which, for convenience, could be segregated and visualized as being on separate

[1]Acknowledgment is gratefully made of the assistance of Professor H. H. Chapman, of Yale University; Mr. W. E. Bond, of the Southern Forest Experiment Station; Messrs. E. H. Frothingham, C. F. Korstian (recently resigned), and A. L. MacKinney, of the Appalachian Forest Experiment Station; and the members of the staff of the Forest Taxation Inquiry in helping to organize this project and in criticizing this paper.

areas. Fortunately, yield tables for fully stocked stands of even-aged second-growth southern pine were available (11).

Fortunately also, besides the Inquiry's study of forest taxation in Beaufort County, the Southern Forest Experiment Station initiated a study of the financial aspects of forestry in the same county, shortly after the Inquiry had started its work. As a result, the following method was worked out in Beaufort County and was used also, essentially in the same form, in Chatham County.

Contrary to the usual procedure in the selection of sample plots (that is, selecting them in the field), the selection of sample properties was made from the county tax records. This was made possible by the description of each property which was found on the county "abstract." The "abstract" (a misnomer) was in reality a description of each property made by the assessor. It included the name and address of the owner; legal description of the property; distance from certain towns and from certain named roads; area of cleared, forest, and waste land; and assessed values of each type of land, improvements (buildings), and merchantable timber. With this information it was possible to secure a number of properties with a relatively large amount of forest land, and at the same time to get the properties well distributed over the county. As a result, human prejudices in the selection of the sample were eliminated to a great extent. One hundred and one properties in Beaufort County were selected in this manner. The total area of the sample properties was 20,098 acres, of which 16,196 acres were forest land. This is 4.2 per cent of the total area of forest land in the county. In Chatham County, 147 sample properties were selected. These samples consisted of 20,946 acres of forest land, or 6.8 per cent of the forest land in the county.

The following steps were carried out in the field by the Inquiry for each sample property:

1. The area of cleared land, waste land and forest land was determined. This had already been done by the assessor but a check was made and the classification changed in a great many cases. Most of the areas classified by the assessor as "waste" were classed by the Inquiry as forest (10). Some few areas consisting of tidal marsh, savannah and cut-over land not reproducing (153 acres on the selected properties in Beaufort County) were left as waste. These area estimates were made ocularly, with the help of the land owner or tenant (who could usually give a good estimate of the amount of cleared land, actual areas as registered on machine planters being the basis for many of these estimates), and also of a local man secured to locate the property, who was familiar with the locality and was trained in estimating areas and timber.

2. The area of forest land was separated into pine and hardwood areas. This was also done ocularly and with the aid of the occupant of the land and the property locator. There was usually a rather distinct line of demarcation between the pine and hardwood areas. When they were in mixture, however, so that neither one of the types was distinctly dominating, it was necessary to visualize each type as a separate area apart from the other. Cases of this kind were relatively few in number.

3. The area of pine land was divided into areas occupied by different condition classes. The bases for designating condition classes were age, height and degree of stocking (density).

4. For each condition class, the average age, average height of dominant trees and density were determined. The age was determined from increment borings on from 1 to 5 representative trees. All ages were rounded off to the nearest 10-year age class. After familiarity with

nditions was gained, in order to speed the work, the ages were guessed at some cases. Numerous checks, how-er, were made. Heights of from 1 to dominant trees were estimated by eye, eraged and rounded off to the nearest oot height class. Density was esti-ated by eye in tenths of a fully stocked and; *i. e.*, a stand with a density of 2 is two-tenths stocked.

5. Notations were made as to the age d diameter of hardwoods whenever umps were encountered. This was done order to get a comparison between owth of pine and hardwoods as a basis r a rough growth figure for hardwoods.

Individual Tree Method

The Southern Forest Experiment Sta-on selected 50 of the 101 properties in eaufort County for their samples and n one or more one-acre strips on each them. These strips were 1 chain wide d 10 chains long and were taken in erage stands of each property. On each rip, every live tree was tallied by di-neter and by species to get the present olume. Both pine and hardwoods were llied, but growth data taken only for ne (since the Station's study was of ne only). On each strip 3 to 5 repre-ntative trees were bored and total age btained. Diameters were taped, heights easured with a hypsometer and radial rowth during the last 10 and the last) years measured. For comparison with e Inquiry's data, only 20 of the 50 rips could be used, because 30 of the tation's strips were run through mixed ondition classes, where it had been ecessary for the Inquiry to segregate ach condition class and treat each as if were on a separate area. This compari-on on the 20 sample areas is given in able 1, of which more will be mentioned ter.

From the Station's field measurements the following data for each strip were compiled (1):

1. Present volume of the pine timber over 9 inches in diameter at breast height was computed from volume tables by the International one-quarter inch kerf log rule (11).

2. The site index was determined. On each plot the site index of each tree bored was determined from the age-height curves (11). The average site of all the trees represented the site of the plot.

3. The age was determined by borings.

4. The density was computed by means of basal areas.

5. Current annual growth per acre was predicted for the next 10-year period. Growth was figured separately for each plot in the following manner:

The number of trees of each 2-inch diameter class was reduced for mortality as follows: 2-inch, 20 per cent; 4-inch, 15 per cent; 6-inch, 12½ per cent; 8-inch, 10 per cent; 10-inch, 7 per cent; and 12-inch and larger, 5 per cent. These reductions for mortality were determined from stand tables (11) as applied to actual conditions in the field. From 3 to 5 dominant trees were measured as to height. Borings of these trees were also made, and diameter growth during the past 10 and past 20 years was measured. The diameter growths were then averaged by means of rough curves, and the present trees which will survive 10 years from now were raised in diameters and put into new diameter classes, according to these curves. To predict height growth, a rough curve of height on age was made of the trees bored on each plot. For the site index of each plot the increase in height in 10 years which might be expected at the ages of the trees bored was read from the site curve (11). From this, and from the rough curve of actual present heights, a table was made of tree heights 10 years hence for each 2-inch diameter class. If enough ages were not represented, the site curve was relied

TABLE 1

BASIS FOR PERSONAL CORRECTION FACTOR FOR GROWTH PREDICTIONS; OCULAR OBSERVATIONS BY FOREST TAXATION INQUIRY AS CHECKED BY SOUTHERN FOREST EXPERIMENT STATION STRIPS ON TWENTY SAMPLE PROPERTIES

(Beaufort County, North Carolina, 1930)

Property number	Age		Site index		Density		Volume per acre (board feet-International ¼ inch kerf log rule)						Current annual increment (board feet-International ¼ inch kerf rule)		
							Present			Ten years hence					
	F. T.I.	S.F. E.S.	F. T.I.	S.F. E.S.	F. T.I.	S.F. E.S.	Individual tree method (S.F.E.S.)	Yield table method (F.T.I.) Actual	Yield table method (F.T.I.) Corrected	Individual tree method (S.F.E.S.)	Yield table method (F.T.I.) Actual	Yield table method (F.T.I.) Corrected	S.F. E.S.	F.T.I. Actual	F.T.I. Corrected
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
B 1	30	40	100	70	0.50	0.20	1,788	9,950	2,900	4,772	16,050	3,980	298	610	108
B 2	40	50	80	70	0.60	0.35	8,026	11,940	6,965	12,665	16,020	8,400	464	408	144
B 3	50	35	80	90	0.20	0.49	10,788	5,340	10,192	19,005	6,240	14,847	822	90	466
B 3a	40	30	80	90	0.80	0.52	2,895	15,920	8,008	10,248	21,360	13,416	735	544	541
B 4	70	35	60	75	0.20	0.26	5,042	3,980	3,523	10,040	4,340	5,343	500	36	182
B 11	30	25	90	70	0.60	0.45	2,519	9,240	1,845	7,716	15,480	5,085	520	624	324
B 18	40	35	100	55	0.20	0.16	1,202	6,420	1,008	3,149	8,240	1,808	195	182	80
C 2	20	25	60	70	0.50	0.17	560	0	697	3,804	2,050	1,921	324	205	122
C 8	40	40	80	70	0.30	0.27	4,207	5,970	3,915	7,448	8,010	5,373	324	204	146
C 13	50	30	80	60	0.60	0.26	3,188	16,020	1,066	4,779	18,720	2,340	161	270	127
C 16	60	65	70	80	0.60	0.50	15,316	14,400	16,500	18,822	16,020	17,850	351	162	135
L 5	40	35	70	80	0.80	0.27	2,895	11,600	4,266	7,755	15,920	6,345	486	432	208
L 8	30	35	70	80	0.60	0.30	5,551	4,620	4,740	8,620	8,700	7,050	307	408	231
L 15	30	35	70	70	0.80	0.52	7,672	6,160	5,876	12,410	11,600	9,152	474	544	328
P 3	40	20	80	90	0.20	0.19	2,672	3,980	855	5,616	5,340	2,926	294	136	207
R 9	50	30	80	90	0.70	0.59	11,347	18,690	9,086	19,909	21,840	15,222	856	315	614
R 11	30	35	70	95	0.80	0.34	8,681	6,160	7,990	13,242	11,600	11,458	456	544	347
W 1	30	20	70	90	0.60	0.43	1,416	4,620	1,935	9,406	8,700	6,622	799	408	469
W 2	30	25	80	60	0.60	0.18	179	6,780	324	1,085	11,940	1,134	91	516	81
W 6	30	20	60	80	0.60	0.41	2,975	2,460	1,107	9,004	5,400	4,633	603	294	353
Total	780	665	1,530	1,535	10.80	6.86	98,919	164,250	92,798	189,495	233,570	144,905	9,060	6,932	5,213
Average	39	33	76	77	0.54	0.34	4,946	8,212	4,640	9,475	11,678	7,245	453	347	261

Sources of data:

Columns 1, 3, and 5: Forest Taxation Inquiry field observations on sample properties.
Columns 2, 4, 6, 7, 10, and 13 from computations made on Southern Forest Experiment Station sample acre strips.
Column 8 computed from Columns 1, 3, and 5, and Table 53, p. 73, U.S.D.A. Bul. 50.
Column 9 computed from Columns 2, 4, and 6, and Table 53, p. 73, U.S.D.A. Bul. 50.
Column 11: Same as Column 8, except that 10 years were added to the age in Column 1.
Column 12: Same as Column 9, except that 10 years were added to the age in Column 2.
Column 14: Column 11 minus Column 8, divided by 10.
Column 15: Column 12 minus Column 9, divided by 10.
Averages: Total of each column divided by number of samples (20).

›n. Volumes of the present stand and stand in 10 years were then com-ed from volume tables (International inch kerf rule) (11) and the differ-e between the two divided by 10 gave current annual growth during the t 10 years.

A Compromise Between the Two Methods

The Inquiry's office procedure was as llows (Inquiry field data were used cept as indicated):

1. The site index for each condition ss was determined. It was read from age-height curves (11).

2. With age and site index as bases, yield per acre for each condition ss was read from the yield tables (12). e yields were compiled for three dif-ent log rules for various reasons—the yle rule because it is the legal rule in rth Carolina, the International ¼-inch rf rule because it gives volumes nearer the actual amount sawed out by the ills in the locality, and the Scribner cimal-C rule because it was considered sirable to compare growth in all three unties, and the Scribner rule is the one nployed by the United States Forest rvice (the only rule for which volume bles are available) in Macon County.

3. To arrive at volumes of the stands they are actually stocked at present, e tabular volumes in each case were re-uced by the density percentage.

4. Ten years were added to the age of ch stand and the tabular volumes read; e volumes were then reduced by the ensity percentage. The assumption was ade in this step that the density of the and will remain the same during the 0-year period. This assumption is the ource of the principal errors in the ield table method, because, other factors emaining the same, the stand should nd to approach full stocking. Gevor-iantz and Zon (5) state that this tendency is not great (if the stand is not too young) for a period up to 20 years for white pine in Wisconsin. However, it will be somewhat more pronounced in the South where faster growth occurs. But in this connection Forbes and Bruce (2) say that since no definite information is yet available, a conservative assumption should be made that the stocking of southern pine remains the same throughout the forecast period. McArdle and Meyer (8) set a tentative rate of change toward normality at 4 per cent during each decade for Douglas fir in the Pacfic Northwest between the ages of 40 and 80 years, based on studies made on permanent sample plots by Hanzlik (7) and Meyer (9). It is probably safe to say that the comparatively young stands of fast-growing pine found in North Carolina will advance towards normality at a faster rate than the Douglas fir. This evidence shows, therefore, that the assumption that stands will remain at the same density during the prediction period will give too conservative á result. A correction was accordingly made in a later step.

5. Ten years more were added to the age of each stand and the tabular volumes read. This was done to determine the growth for a 20-year period. These volumes were also reduced by density percentages.

6. The annual growth per acre was computed for each stand. This was accomplished by subtracting the present volume from the predicted volume for the period under consideration and dividing the result by the number of years in the period.

7. The annual growth per acre for each stand was reduced by approximately 25 per cent, the personal correction factor, which was applied to rectify errors in the Inquiry's ocular estimates of density, height, and age. The data in Table 1 form the basis for the derivation of this factor. Columns 7 and 10 in the

table give the volumes on the Southern Forest Experiment Station strips which are to be contrasted with Columns 8 and 11 which show the volumes on the Inquiry plots. To take care of the differences between the Inquiry's ages (Column 1), densities (Column 5), and site indices (Column 3), and the comparable measurements made by the Station (Columns 2, 6 and 4), Columns 9 and 12 were worked out by using the Station's figures for age, site index, and density. The resultant growth figures are found in Columns 13, 14, and 15. The average annual growth per acre on the Station's strips (Column 13) is 453 board feet, the comparable figure for the Inquiry's plots (Column 14) is 347 board feet, and the comparable figure for the Inquiry's plots corrected as to age, site index, and density by using the Station's figures (Column 15) is 261 board feet. The corrected Inquiry figure (261 board feet) is about 75 per cent of its original figure (347 board feet), which means that each sample stand of the Inquiry had to be reduced by approximately 25 per cent (personal correction factor) to take care of the inaccuracies of the ocular measurements.

The Station's average current annual increment for the 20 plots (453 board feet), obtained by the individual tree method, is about 42 per cent higher than the Inquiry's corrected average current annual increment (261 board feet), obtained by the use of yield tables. The yield table method always gives the lowest possible figure, because by its use, mortality is automatically taken care of. The error in this method is probably due mostly to the conservative assumption, already noted, that the density of stands remains the same as they grow older. It would appear, from the large figure obtained by the individual tree method, that the growths were not reduced sufficiently for mortality (the greatest source of error by this method). The correct growth figure probably lies somewhere betwe 261 and 453 board feet, but just ho much more weight one method should given over the other is impossible to d termine. The assumption was mad therefore, that one method erred as mu in one direction as the other meth erred in the opposite direction, and th the correct figure is just half way b tween, or 357 board feet per acre.

8. As a result of this assumption, t annual growth of each stand was rais by 27 per cent (after it had been lo ered by 25 per cent in the precedi step). The net result, actually, was multiply the Inquiry's original annu growths for each stand by 1.0288, whi is the ratio of 357 to 347 board feet. Th same correction factor was also used Chatham County because it is reasonab to assume that a method employed b the same person in two localities wi similar conditions will result in a simil error.

9. A weighted average annual grow per acre was computed by multiplyi the growth per acre for each stand by i area, getting the total and dividing b the total area of the sample propertie This figure was multiplied by the tot area of pine land in the county to a rive at the total current annual pine i crement for the county.

10. The average annual growth of har woods was determined approximately o the basis of diameter and age. It w first assumed that the density of har wood stands is the same as that for pin (which may or may not be true) an that the diameter and age will give an i dication of the difference in growth b tween pine and hardwoods; height an form of trees were assumed to be co stant (also probably an unwarranted a sumption, but the only possible cour under the circumstancs). The average d ameter and average age of each pi stand were determined in the field. The were totaled and divided by the numb

bservations to get an average for all ds. Increment borings in hardwoods e found not to be feasible; therefore s were counted on stumps, wherever were encountered, and diameter st high was estimated from the nps. In this way it was possible to an average diameter and average age ardwood trees to compare with simi- averages for pine. The following nula was used:

$$r = \frac{d_p \; a_h}{a_p \; d_h}$$

ere r = ratio of rate of growth of pine to hardwoods
d_p = average d.b.h. of pine
a_p = " age of pine
d_h = " d.b.h. of hardwoods
a_h = " age of hardwoods

3y this computation, pine was found be growing at twice the rate of hard- ods in Beaufort County and one and -half times in Chatham. The slower wth of hardwoods in Beaufort County y probably be explained by their lespread occurrence in swamps. The wth of hardwoods was determined, n, by dividing the pine growth figures 2 for Beaufort and by 1.5 for Cha- m. The resulting average current an- al hardwood increment figures were n applied to the total area of hard- ods in the county. These calculations, course, are only approximate but they l serve better than mere guesses and l also preclude disregarding the wth of hardwoods, which is in itself error.

Macon County—Individual Tree Method

In Macon County it was necessary to vise an entirely different method. This unty is in the Southern Appalachians, d its timber is characterized by an even-aged, mixed condition. The basis for the method used was suggested by the Director of the Appalachian Forest Experiment Station as one which had been devised years ago and had never been given a fair trial. The method is explained in an office report of the Appalachian Station (3), and requires the following basic data:

1. A diagram representing by age-height curves a single series of 5 site qualities based upon height growth, from Site I (best growth in coves) to Site V (very slow growth on ridges).

2. Yield table for even-aged, well stocked stands of southern upland hardwoods.

3. Forecast tables for individual trees, giving volumes in board feet (Scribner decimal C rule) for different periods in the future, to be used in estimating future yields per acre in uneven-aged stands and in stands not well stocked.

Table 2 is a sample of the forecast tables. The tables were constructed in 1920 from stem analysis data collected from individual dominant trees in the southern Appalachian region. From these data, trees were selected which showed total height and age, so they could be related to the site classifications. The procedure was similar to that followed by Frothingham and Barrows (4) in working out the selective maximum diameter growth for Michigan beech. The data were averaged by means of curves of diameter on age, both for rapid and slow diameter growth. In this way the diameter growth was obtained in each decade for all trees of a given species, which was then related to the present diameter; i.e., future diameters by decades were predicted for each 2-inch diameter class. From these predicted diameters, and an average curve of height on age for each site, predicted volumes were computed by using volume tables existing at the time. These growth predictions are admittedly only approximate, and because of the fact that it was impossible to

check the tabular volumes, the growth data for Macon County are considered less accurate than in either Beaufort or Chatham.

Due to the fact that almost one-third of the land in Macon County is in the Nantahala National Forest, growth was determined for national forest land separate from privately-owned land. For privately-owned lands 56 sample properties were selected in the same manner as in the other two counties. In addition, 28 sample areas of national forest land were selected from acquisition examina records with the aid of a map. Inst of estimating the growth on the t area of forest land on each sample was done in Beaufort and Chatham co ties), average half-acre strips (1 ch wide and 5 long) were run. On th strips the following data were taken. even-aged, well stocked stands were countered, so the individual tree meth employing the tables of which Tabl is a sample, was used in all cases):

1. Heights and ages of from 2 t

Table 2

TREE VOLUME FORECAST TABLE SHOWING INCREMENT OF INDIVIDUAL DOMINANT TREES

RED OAK, SITE III

(Board Feet—Scribner Decimal C Rule)

Present d.b.h. (inches)	Present volume based on constant height growth		Volume 10 years hence based on constant height growth		Volume 20 years hence based on constant height growth	
	Rapid d.b.h. growth[1]	Slow d.b.h. growth[2]	Rapid d.b.h. growth[1]	Slow d.b.h. growth[2]	Rapid d.b.h. growth[1]	Slow d.b.h. growth[2]
	(1)	(2)	(3)	(4)	(5)	(6)
2	—	—	—	—	—	—
4	—	—	—	—	40	—
6	—	—	30	—	80	60
8	30	40	70	80	130	120
10	60	80	120	130	190	170
12	100	130	160	180	240	230
14	150	190	230	240	310	290
16	210	250	290	300	400	360
18	270	310	380	380	500	450
20	350	390	470	470	610	550
22	440	470	580	570	730	650
24	550	590	690	670	850	770
26	660	700	820	800	980	900
28	790	830	950	930	1,120	1,030
30	930	970	1,100	1,070	1,260	—
32	1,080	—	1,240	—	1,430	—
34	1,240	—	1,400	—	1,580	—
36	1,400	—	1,580	—	1,760	—
38	1,560	—	1,740	—	—	—

[1]Volume of dominant trees in less dense stands, where diameter growth is rapid as comp with height growth.

[2]Volumes of dominant trees in dense stands, where diameter growth is slow as compared height growth. Under "present volume," a given diameter, therefore, indicates a greater age height, and, hence, a greater volume, in Column 2 than in Column 1. The difference in diam growth, however, soon equalizes the volumes, after which those figures corresponding to rapid diam growth are the greater.

inant trees were determined by meas-nents and borings. The site quality each strip was determined in the field the use of the curves of height on Where relatively rapid growth, in-rant trees were mature; *i.e.*, when had practically stopped growing in ht, it was not necessary to determine age because the height of the tree, if were dominant, would indicate the quality.

. All living trees were tallied down 2 inches d.b.h. by species, by 2-inch meter classes, and by rough crown sses; *i.e.*, dominant, intermediate, and pressed.

he office computations were as fol-s:

. For each strip the stand was classi-l on the basis of relative rate of di-eter growth. This was necessary be-se the tables give two different sets volumes, based on rate of diameter wth, as is shown in Table 2.

This division was made roughly on the is of number of trees per acre; *i.e.*, the stand had over 100 trees per acre the diameter classes from 2 to 10 hes inclusive, or if it had over 50 es per acre 12 inches or over in di-eter, the slow diameter growth vol-es (Columns 4 and 6 in Table 2) re used, and on the lighter stands hich were by far the most prevalent), rapid diameter growth volumes (Col-ns 3 and 5 in Table 2) were used.

2. The present volume on each strip s read from Column 1 or 2 in Table The forecast tables were available for ly four species; namely, red oak, yel-w poplar, white oak, and chestnut oak, d the tables had to be adapted to the her species as well as possible; *e.g.*, e red oak table was also used for black d scarlet oak and black locust. Conifer lumes were computed from volume bles available for the various species. e volumes were computed for all spe-es, and separate volumes for those species which are considered merchantable at the present time; namely, yellow poplar, oak, locust, hemlock, and pine. Subsequent growth computations were made on the same basis.

3. The volume in 10 years was read from Column 3 or 4 in Table 2. Dominant and intermediate trees only were used in this computation, the assumption being made that most of the trees in the lowest (suppressed) crown class will die out or cease growing perceptibly, and that the growth of some of the trees that live will be offset by mortality in the upper crown classes. Chestnut was not considered in the growth because it has been predicted (6) that by 1935, nine-tenths of the counties in the southern appalachian range of chestnut will have reached the 80 to 100 per cent stage of infection with chestnut blight.

The future volume of conifers was determined from yield, volume, stand, height, and diameter tables. Conifers formed such a small portion of the stand that their growths were interpolated roughly from the tables which are available for the region.

4. The average annual growth per acre for the 10-year period was computed by subtracting the present volume from the volume in 10 years and dividing by 10.

5. The volume in 20 years was read from Column 5 or 6 in Table 2. Dominant trees only were included for this period, the assumption being made that the suppressed, and also the intermediate trees, will die out during the period, or that their small growth will be offset by mortality in the dominant class. This assumption, and the one made for the 10-year period, might possibly result in an unjustifiable reduction for mortality. By actual computation, however, the percentages of the number of trees deducted (by diameter classes) are those given in Table 3. The figures in this table under the 10-year period represent the percent-

ages of the total number of trees in the present stand which are in the suppressed class (disregarded in the growth predictions for the 10-year period). These reductions are not greatly different from those made by the Southern Forest Experiment Station in Beaufort County (cf. p. 6 and 7) for a 10-year period, being somewhat more for the smaller trees and less for the larger ones. The figures under the 20-year period represent the percentages of the total number of trees in the present stand which are in the suppressed and intermediate classes (disregarded in the growth prediction for the 20-year period) which, though considerable, are believed not to be excessive.

TABLE 3

REDUCTION FOR MORTALITY BY PERCENTAGE OF TOTAL NUMBER OF TREES IN EACH DIAMETER CLASS

(Macon County, North Carolina)

D.B.H. (inches)	10 year period (per cent)	20 year period (per cent)
4	30	65
6	20	59
8	11	43
10	6	26
12 and over	2	12

6. The average annual growth per acre for the twenty year period was computed by subtracting the present volume from the volume in twenty years and dividing by 20.

The growth data arrived at by the use of the methods described here are given in Table 4.

REFERENCES

1. Bond, W. E., 1931. Financial aspects of management of southern pine in Beaufort County, North Carolina. Unpublished manuscript of the Southern Forest Experiment Station.

2. Forbes, R. D., and Bruce, Donald,

TABLE 4

AREA OF FOREST LANDS AND CURRENT ANNUAL INCREMENT PER ACRE

(Selected Counties, North Carolina, 1930)

County	Area of forest land (acres)			Current (20 year period) annual increment per acre (board feet)								
				Doyle rule			International 1/4 inch kerf rule			Scribner decimal C rule		
	Pine	Hardwoods	Total	Pine	Hardwoods	All species	Pine	Hardwoods	All species	Pine	Hardwoods	All species
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Beaufort	258,000	129,000	387,000	201	100	167	301	150	251	284	142	237
Chatham	212,000	95,000	307,000	263	175	236	451	301	405	390	260	442
Macon			267,000									350

1930. Rate of growth of second-growth southern pines in full stands. U. S. D. A. Circular 124, p. 49.

3. Frothingham, E. H., 1920. Growth forecast tables for southern upland hardwoods in the Southern Appalachians. Unpublished manuscript of the Appalachian Forest Experiment Station.
4. Frothingham, E. H., 1915. The northern hardwood forest; its composition, growth, and management. U. S. D. A. Bulletin 285, p. 38.
5. Gevorkiantz, S. R., and Zon, R., 1930. Second-growth white pine in Wisconsin; its growth, yield, and commercial possibilities. Wisconsin Agr. Exp. Sta. Research Bulletin 98, p. 36.
6. Gravatt, G. F., and Marshal, R. P., 1926. Chestnut blight in the Southern Appalachians. U. S. D. A. Circular 370, p. 7.
7. Hanzlik, E. J., 1914. A study of the growth and yield of Douglas fir on various soil qualities in western Washington and Oregon. For. Quart., 12, pp. 440-451.
8. McArdle, R. E., and Meyer, W. H., 1930. The yield of Douglas fir in the Pacific Northwest. U. S. D. A. Tech. Bul. 201, p. 33.
9. Meyer, W. H., 1928. Rates of growth of immature Douglas fir as shown by periodic remeasurements of permanent sample plots. Journ. Agr. Research, 36, pp. 193-215.
10. Wager, P. W., and Thomson, R. B., 1931. Taxation of forest property in North Carolina. Forthcoming progress report (No. 17) of the Forest Taxation Inquiry.
11. 1929. Volume, yield and stand tables for second-growth southern pines. U. S. D. A. Misc. Pub. 50 pp. 7-147.

"To us as to the ancients the tree is still the patron of fertility; as those have iscovered to their cost who have bared a country of its forests. To us as to them t is still the thing of all things living that is endowed with the most enduring life, he most persistent vigour. Generations come and go, but the tree lives on and every pring puts forth new leaves, and every autumn bears new seed, and even to its last ecrepitude the leaves are as green and the seeds as full of life as in the prime of its outh. What changes has not the oldest tree in England witnessed! In the southern ounties there is an ancient way, once thronged by travellers, but now deserted and roken in its continuity; yet to this day, even where parks and pastures have overlain t, its course may still be traced by the yew-trees planted at its side by pilgrims ourneying to the shrine of St. Thomas of Canterbury, in the days when their brothers vere fighting for the White Rose or the Red."

The Sacred Tree, by Mrs. J. H. Philpot, London, 1897.

FOREST FIRE PROTECTION IN THE SOUTHERN PORTION OF WEST VIRGINIA[1]

By C. H. TRACY

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The fire protection association here described is an example of a successful coöperative effort between individuals and the state. The protection work in the region discussed has a four-fold support: the association contributes on a one-cent-per-acre basis; the state contributes 25 per cent of its receipts from the sale of fishing and hunting licenses; the county pays suppression costs; and the federal government gives financial aid under the Clarke-McNary law. The state directs and supervises the work but the association keeps in close contact with it through field managers and otherwise shows its interest in adequate protection.

THE STORY of forest fire protection in southern West Virginia is essentially the story of the Southern West Virginia Forest Fire Protective Association. At various times in the past descriptions of our organization and its work have appeared in forestry journals.

While West Virginia is not sectional, for the purposes of forest fire protection two association areas have been formed in addition to the five forest districts of the state organization. Southern West Virginia includes geographically that portion lying south of the Kanawha and New Rivers, twelve counties, with a forested area of some three and three-quarters millions of acres exclusive of farm woodlots. Through the State Game, Fish and Forestry Commission and the Southern West Virginia Forest Fire Protective Association we have organized protection of one million three hundred thousand acres of these timber lands. Practically all of the forest in this area is of hardwood types, with a scattering of white pine type.

The history of fire protection in this portion of the state is one of steady progress during the fifteen years since its inception. To quote a former discussion of the problem—"Prior to the year 1916 forest fires were prevalent. These fires burned unchecked through every dry period with a resultant destruction beyond our power to compute." Previous to t[...] time little consideration was given me[...] of combatting the menace of fires. But [...] 1916, with a nucleus of 97,500 acres [...] the holdings of coal land companies, a[...] with assurance of coöperation on the p[...] of the state and the federal governme[...] this association was formed. In the s[...]ceeding five years, through 1920, the [...]sociation functioned as an independ[...] organization, placing men on patrol d[...]ing dry weather, building two look[...] stations, and increasing threefold its a[...] under protection. Reports of 1921 sh[...] an acreage of 274,906 acres in the [...]sociation and a large increase from t[...] original six in the list of member la[...] owners. The year 1921, which ma[...] another step forward, was the beginni[...] of the close coöperation between the [...]sociation and the game and fish comm[...]sion of the state, then but newly [...]ganized on its present basis. At t[...] time the state took over for itself [...] actual supervision of our protection [...]ganization, handling the association fu[...] and its own and federal coöperat[...] money jointly. The next four years [...] expansion of area and growth in int[...]sity of protection afforded are summ[...] up in a report of 1924 listing 39 mem[...] land-owners in the association and [...]other substantial increase to 610,427 ac[...] under protection. Twelve towers app[...]

[1]The author is also Field Manager for the Southern West Virginia Fire Protection Association.

the inventory, and thirty-three men on
e payroll. When we next take stock, at
e end of 1930, we find 1,300,000 acres
ted, nearly 35 per cent of the total
tential area that could be brought
der protection, and an organization to
ovide adequate protection of the lands
the 279 coöperating member-owners
in readiness, with a state-association-
id force of 94 rangers and towermen,
towers, and two full-time district for-
ters. Looking back over the past fifteen
ars one sees a gratifying result of the
rnest endeavors of the folks whose in-
rest has been the protection of southern
est Virginia's forests.

The present make-up of the coöperat-
g bodies interested in the work of fire
otection in this region is at present
urfold—state, association, federal, and
unty, each with a very definite rôle in
e scheme, both financially and adminis-
atively.

The state, through its Game, Fish and
orestry Commission, assumes the direc-
on of the personnel and organization,
nder the supervision of its Chief For-
ter and two of its staff of district for-
ters. A very substantial portion of the
nds for operation is also provided
rough the commission. Under the for-
t protective acts and game and fish
ws 25 per cent of the receipts from the
le of game and fish licenses are appro-
riated to the use of the forest depart-
ent—for use throughout the whole state,
f course. This has been a sum almost
qual to that contributed by the one-
ent-per-acre assessments against the as-
ociation members, in the proportionate
hare devoted to the work in southern
Vest Virginia. And not one cent of this
mount, around $50,000 a year for the
tate as a whole, has come from the
irect appropriation of tax monies by
e legislature. In other words, through
e medium of the Game, Fish and For-
stry Commission the sportsmen of the
tate match the land owners voluntarily
in contributing to the support of forest fire protection. (Incidentally, plans are under way for securing for the ensuing year our first direct legislative appropriation.)

The part played by the federal government under the Clark-McNary law is familiar to every forester. The financial aid serves as perhaps the greatest inducement to forest protection in the case of many people. And the inspection and requirements imposed serve to maintain and elevate the standards of protection afforded—an admirable check and balance in a state, non-civil-service activity like ours West Virginia.

The association's part of late has been much like that of the federal government—contributing the funds derived from assessment of its members and keeping a watchful eye on the state's administration of the work. Having been the founder of the project, just as the federal government was a prime mover in inducing private land-owners in general to practice forest protection, it has, like the government, satisfied itself with merely contributing and watching of late. The financial part it plays through the one cent per acre assessments upon its members results in the collection of $13,000 annually for use in the section. Since the very severe spring fire season of 1930 it has become aroused from its policy of standing by and has once more become an active unit in administration of the work. A new arrangement with the state department has been made, by which the association assumes directly the payment of fifty per cent of the personnel employed, pays part of the salaries of each of the two district foresters as its field managers, and through a very active forest fire committee keeps in direct contact with field supervision. It is also planning the expansion of the area under protection to 100 per cent, and by a resolution of July, 1930 it is demanding that expenditures for protec-

tion be made on the basis of 2 cents per acre per year, and budgeted on this basis. The part played by the association cannot be overestimated. As stated, the story of the work in this region is largely that of its progress. In several of the dark moments in West Virginia state forestry the association has carried the work through by its moral and financial support. It is claimed for the association that it is the largest east of the Rockies, in point of acreage listed.

We come now to the counties' part in the scheme. This is a passive part, bearing a share of the financial burden, (sometimes almost too passively). Under the Forest Protective Acts of the state it is the duty of the various counties to pay directly to the men summoned and to persons furnishing subsistence supplies and transportation, all the suppression costs of the fires. This is done from money available from the general county fund and from collections, wherever this is possible, of suppression costs from the parties responsible for the fires. These suppression costs have been a small part of the total expense of fire protection in former years. But in 1930 under the extreme conditions that prevailed costs piled up until payment of fire claims has become a major problem for several of the county courts. It might be added here that this payment of suppression costs by the counties is the only way in which tax monies are directly contributed to support of the work, except through the federal government, of course. And inasmuch as the greater part of the taxes in these counties is paid by the large land-owning companies, o of which owns 250,000 acres of forest lands, it really comes back upon the a sociation members. Means of perfectin the system for payment of such cos handling them directly through the sta forestry department, with lump-sum a counting with the counties at fixed p riods, are being considered. The prese method by which the counties issue th claims directly to each individual is pro ing inadequate and inefficient.

Organization for forest fire protectio in the southern part of West Virgin is then fourfold. The state and a sociation handle the operation of th work jointly and contribute funds equall the federal government aids in financin and imposes very welcome standards an checks on the non-civil-service state o ganization; while the counties pay th direct costs of fire suppression. All fou interlock to create the system by whic forest fire control is handled. Only on other similar arrangement exists in th state, that of the Central West Virgin Fire Protective Association[2] in parts two of the other state forest district

In the operation of the protection o ganization in the field, the same schem applying to the other three forest di tricts of West Virginia is in effect. T describe this scheme in brief for th two forest districts involved—the Kana wha and Pocahontas—organization is a follows: Two district foresters, who ar also field managers for the associatio have almost equal districts in divisio of the acreage. The two districts are sub divided into sections, two in the Kanawh

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[2]*Editor's Note:*—According to former State Forester, H. S. Newins, this association was form in 1914, and its present membership represents 500,000 acres. The association contribution is o cent per acre, just as in the Southern association. In both associations the voting per member is o vote per 1,000 acres. Both have been important factors in stimulating interest in better protectio A state law requires that owners of more than 360 acres of forest land must provide adequate f patrol. This law has been an important factor in swelling the membership of the associations. third association, the Eastern, was formed in 1921 and ceased functioning in 1926 but there is a p sibility of it being reorganized.

strict, four in the Pocahontas, with mporary men called section rangers in arge of each in fire season. These sec- ns are in turn subdivided into the 17 wer units necessary for detection pur- ses. In turn each of these is divided to from one to three ranger areas, 71 all. Each of these divisions and sub- visions is manned by men who are id for their services through the state the association, a total of 96 men. addition each ranger has from two to elve sworn local fire wardens in his ea, paid only for actual time employed fire suppression, the total of these be- g 500. So we have developed an or- nization of some 600 men.

Among the physical assets owned by e state and association are the 17 fire bservation towers, 170 miles of tele- one lines, automobiles for the district resters, and the usual equipment of e-fighting tools.

Fire conditions are those peculiar to e hardwood forests. Two fire seasons, ll and spring, are recognized, although 1930 the two merged into one contin- us period of fires through the drought riod. The fires are all surface fires in llen leaves or in logging slash, and eep rapidly over the ground, leaving easily visible impression after them do fires in coniferous types. The ound is of exceptionally broken topog- phy, making tower detection especially fficult and necessitating careful triangu- tion methods. Suppression work is simi- rly difficult in the steep, rocky hills. wnership is concentrated in the hands comparatively few coal and land com- anies with very large holdings—witness e 250,000 acres of the Pocahontas Coal d Coke Company. There are no state national forest lands in this region. ands are held chiefly for their mineral alues, coal and gas developments, with condary values in the timber now that e old growth has practically all been gged. Parts of the areas are thickly settled with coal mining camps, increasing the fire hazard, but at the same time increasing the accessibility of the lands by development of good roads. The few cleared lands found in this part of the state are mostly small corn patches and clearings for the little mountain farms. There is no extensive agricultural development, the total forested area of the region being 85 per cent of all of the land in the twelve counties. Four of the more southerly counties are more than 90 per cent forest land, and much of the present cultivated land is essentially valuable only for growing timber. From 400 to 1,000 fires occur annually in the two districts, 1930 being the worst season on record with a total of 1,400 fires.

Possibilities for expansion are great, with but 35 per cent of the forested area, exclusive of woodlots, at present under organized protection, and with much of the still unprotected forest in the hands of large land-owning companies. But this is a far cry from the 3 per cent which was the nucleus of the work fifteen years ago. A five-year plan for expansion has been drawn up, and the state department has in its employ an educational director who is at present concentrating his attention on bringing in more acreage under protection. It is our hope to have all forested lands in association membership by 1935, with a threefold increase to over three and one-half millions of acres listed. The protection organization will have to keep expanding to keep pace with this growth. Forest fire protection in the southern portion of West Virginia is comparatively young reckoned alongside work of our neighboring states, but our association is rapidly growing up and on its twenty-first birthday, in 1937, we hope that it will be full grown. At any rate it is now a strong and lusty youngster, carefully guided by the state and federal governments toward a brilliant future.

A SUCCESSFUL METHOD OF POWER FELLING

By WILLIAM H. WIRT

Forest Engineer, Pacific Lumber Company, Scotia, California

The possibility of lightening the manual labor of felling trees through the use of machinery has spurred many European and American inventors to devise practical equipment. It has remained, however, for the workmen themselves to develop a machine from a standard drag saw and have it adopted to the exclusion of the hand cross-cut saw in the country's largest timber. In discussing the conditions which led to the development, the author suggests the possible reasons why earlier machines failed of general application in smaller timber.

FOR MANY YEARS inventors in America and Europe have tried to develop mechancially operated saws for felling trees. While some have been successful from a mechanical standpoint their inventions have failed in general to show attractive savings in the cost of felling. Now it appears that the fir mechanical felling outfit, successful fro both practical and financial standpoint has been developed in the Californ redwood region. It is of particular inte est that the success should have been a tained in very large trees, the redwood

FIG. 1—Power saw in position making the back cut on a 10-foot redwood tree. The outer end of th frame of the machine is supported on an extra driver or spring-board shown at A. Two cuts for th undercut, B, have already been completed and the block between removed. The sloping cut or sni is on the stump in this case and not wholly in view. The extension rod mentioned in the text is show at C and the dog holding it to the tree appears at its lower end. The saw blade is hidden in the cu likewise the pulley and weight added for drawing the saw into the cut are not visible. The hea chopper is preparing a spot for wedges while the second chopper tends the saw and motor.

that the machine should be merely ight modification of the gas-engine-en drag saw, an outfit already per-ed and in long use for crosscutting . Heretofore, the experiments were tly on small or moderate-size trees. conditions that led to the adaptation he drag saw for felling redwood are efore of interest.

he modification of the standard drag into a felling machine in the red-ds has been the result of conditions liar to the region, plus the ingenuity the felling or "chopping" crews in r efforts to increase their earnings. failure of power saws in other re-s has been due not so much to me-nical difficulties as to the fact that r the saw was started in the cut the ators had little to do except watch saw. Furthermore, a disproportionate unt of time was spent moving the from tree to tree and setting it up. the large redwood timber, however, though the area of the cut is large, actual work of sawing is oftentimes than the work of preparation, such cutting down pole-size sprouts and r small trees from around the tree, ing in logs to level the "layout," otherwise preparing the site. More-r, the Pacific Lumber Company, on se operations these saws were devel-d, requires the same two-man crew do both felling and log-making or cking" in order to encourage greater e in planning the felling, and pays the by the piece in order to increase ume per crew and to decrease break-. For these reasons the choppers nselves have been interested in de-oping a mechanical sawing process ch will free their hands for doing other work and make for more effici-use of time. Most choppers were al-dy experienced in the use of the ver drag saw for crosscutting the huge s. The next logical step was to work a way of turning the saw on its side for felling. Several crews tried this until one worked out a practical method, which other crews took up and developed further. At the present time all the company's sixteen crews are using the power saws for felling and some of the outfits have been used successfully for two years. The same equipment is used for bucking. (Figure 2.)

Trees under from 36 to 48 inches in diameter are still felled by hand, except on the most favorable ground, since it does not pay to handle the heavy equipment for the smaller class of trees. The tendency now is to use the machine on every merchantable tree where it will not take too much time to clear out for it and set it up.

The equipment consists of the stand-

Fig. 2—The same machine and tree shown in Figure 1. The tree is now down and is being bucked into logs.

ard gas-driven drag saw outfit, plus extra gas, oil and water cans and a wrench. In the case of exceptionally large trees or those on very steep slopes, extra spring-boards, locally called "drivers," and staging may be required. Modifications in the standard drag saw include inter-changing the gas and water tanks in order to assure cooling water going to the engine jackets when the supply is low; the addition of an extension arm of half-inch pipe with a three-eighths-inch rod telescoped inside it, and a pair of small double blocks, rope and weight (several wedges) to draw the saw into the cut. The rod in the extension arm is fitted with a "dog" at one end to fasten it to the tree (in Figure 1). One-quarter inch holes are bored through the rod and pipe at 6-inch intervals for inserting a pin to adjust the extension rod to a length suited to the tree. The double blocks are rigged to the saw arm and a suitable point on the tree to feed the saw into the cut independently of its reciprocating motion. The outfit is held against the tree by means of the dogs at the broad end of the frame (these are standard accessories), while the farther or narrow end is supported on an extra spring-board placed about 20 inches above the staging as shown at A in Figure 1.

The fallers still work in pairs, with the adoption of the power saw th work is differently organized. The po saw is first set up for making the und cut, and in order to reduce the workl chopping out the large "snipe," or sl ing cut, two saw cuts are made, about six or eight inches above the oth the block between the cuts being p out with bars (Figure 1). It is belie that eventually the sloping cut also r be made with the power saw, in fact, crew has already made such additio modifications to permit this. Both r are required to set up the saw and m it ready for a cut, but once started t can work on other details such as "ri ing" the bark in advance of the saw, p paring spring-board or driver holes a set-up on the "back cut," or other w previously mentioned. Later, while saw is in the back cut, the men finish the undercut by hand.

Since the change to the piecework s tem and power saws, there has been breakage, stumps are noticeably low the length of trunk to the first break increased, and salvage of broken l is improved. It is estimated that po sawing has speeded up felling of large trees 30 per cent, the rate varyi of course, with topography, tree size the like.

SPRUCE-BALSAM FOREST YIELDS IN NOVA SCOTIA AND CAPE BRETON ISLAND

By R. S. JOHNSON

Mersey Paper Company, Limited, Liverpool, Nova Scotia

The author discusses the growth of coniferous forests of eastern Nova Scotia and Cape Breton Island and offers a yield table for the species in the softwood forest type.

DURING 1929 the Mersey Paper Company, Limited, conducted a survey of the forest resources of various tracts of land in eastern Nova Scotia, particularly in the Cape Breton Island. In this survey, rather intensive growth studies were made and the following discussion sets forth some information compiled from the data collected.

Species, Quality and Distribution

The locality in which these investigations were made is primarily a balsam country. Of the total pulpwood on the areas examined, 12.8 per cent is white and red spruce, 7.3 per cent is black spruce and 79.9 per cent is balsam fir. In some sections the spruce content is as high as 68 per cent, while in others it comprises only 2 per cent of the total pulpwood.

The spruce is generally of good quality, fairly good in form, mostly sound, clean and of fair height. The balsam, while of good form and height, is inclined to have red heart and heart rot in many sections. The average diameter for the merchantable wood of these species is about 7 inches, d. b. h., while the height averages about 40 feet.

A small quantity of white pine, hemlock and larch is found through some parts of the district, but these species are so scattered as to be of practically no commercial importance.

In some sections are found extensive areas of mixed stands of hardwood and softwood, and some pure hardwood stands, although balsam is the predominating species. The hardwoods consist of white birch, yellow birch, hard maple, soft maple, beech and poplar, with the birches predominating. In general, the hardwoods are either too small to be of much value or, if large, their quality and form are so poor as to make them of practically no commercial value except as fuel.

History

Most of the timber in the area examined occurs in more or less even-aged stands, averaging about 65 years old. Balsam generally reaches maturity at 60 years, hence these stands are called mature in this article. This even-aged condition of nearly all stands is not the result of a general forest fire for, although some of the areas show evidence of having been burned, most of them show no trace of fire. Neither has there been any extensive logging until recent years.

A possible explanation of this condition is that there was a devasting in-

sect infestation which simultaneously wiped out practically all the stands preceding those that are now mature, but the older inhabitants do not recall seeing or having heard of such an infestation. However, they all remember the "August gale" of 1873. This, it is said, swept over eastern Guysboro Country and most of Cape Breton Island, felling practically all forests except those in well sheltered valleys. From observations made in growth studies, this is plausible, and most of the trees examined that were over 70 years old were those which would have been more or less sheltered from such a wind. 1873 was, of course, only 57 years ago, but reproduction and immature growth up to 15 or 20 years of age would probably not have been blown down. This would account for individuals in the stands ranging from 60 to 80 years of age, but averaging approximately 65 years old.

Forest Types

The forest types recognized are softwood, mixedwood and hardwood. The softwood type includes swamps containing merchantable softwood. These types are differentiated by two site classes: Site I includes areas where growing conditions are from good to average; Site II areas are those on which growing conditions are from fair to poor, and where trees are short and inclined to "scrubbiness."

The types for these spruce-balsam forests are also differentiated according to age classes as follows:

1. Overmature. Stands which are from 80 to 100 years old and are deteriorating.

2. Mature. Stands which are still producing a slight increment and which are from 60 to 80 years old, generally.

3. Young. Stands which are merchantable but still growing well; generally from 40 to 60 years.

4. Immature. Stands in the sapling stage—from 4 feet in height to 4 inches d. b. h.; generally from 20 to 40 years of age.

5. Reproduction. Areas of seedling growth up to 4 feet in height. Natural barrens and muskegs, including areas of stunted growth and areas so severely burned as to be of no apparent potential value, are classed as waste lands.

Reproduction and Growth

The tree growth in this section of the country is about average for eastern Canada, including Ontario and eastward, south of the 50th parallel of latitude.

Natural reforestation is general on forest areas denuded by fires, logging, insect depredations or other destructive agencies. In some cases, the top soil has been largely burned off by a severe fire or by repeated fires, resulting in the area becoming a more or less permanent barren. As a general thing, restocking is fast and certain, though the restocking of denuded areas is not always by desirable tree species. Particularly is this true in the forest following fire, where restocking is often by birch and poplar, or a mixture of these hardwoods with the pulpwood species. Following denuding by agencies other than fire, the tendency is to restock in a high percentage of balsam, and stands cut at ages of less than eighty years generally

TABLE 1

YIELD PER ACRE

SOFTWOOD TYPE

Age years	No. trees per acre	Average d. b. h. inches	Average height feet	Net merchantable volume, cubic feet Average	Total	Periodic annual growth per cent
Species—red and white spruce						
20	588	0.2	5.6			
30	248	2.0	17.1			
40	100	3.6	25.5			
50	44	5.0	31.6	1.3	56.6	
60	24	6.3	36.5	3.2	77.6	3.2
70	19	7.5	40.5	5.3	101.4	2.6
80	17	8.5	43.5	7.2	122.4	1.8
90	12	9.4	46.0	9.2	110.6	
100	8	10.2	48.0	12.3	90.2	
Species—black spruce						
20	445		4.5			
30	246	1.0	11.1			
40	131	2.3	18.5			
50	85	3.3	23.8			
60	64	4.1	27.6			
70	50	4.8	31.0	1.0	48.5	
80	40	5.3	33.1	1.6	65.3	3.0
90	37	5.7	34.9	2.2	80.8	2.1
100	37	6.1	36.5	2.7	100.9	2.2
Species—balsam fir						
20	1,822	0.7	10.0			
30	1,101	2.7	23.0			
40	565	4.3	31.2	0.4	222.5	
50	269	5.6	37.2	2.0	542.3	9.4
60	180	6.6	41.3	3.5	626.0	1.4
70	138	7.4	44.4	4.8	660.2	0.5
80	107	8.0	46.5	5.8	625.9	
90	84	8.5	48.3	6.8	569.2	
100	71	8.9	49.5	7.3	519.0	
Total—all species						
20	2,855	0.5	8.2			
30	1,595	2.4	20.3			
40	796	4.0	28.3	0.3	222.5	
50	398	5.1	33.7	1.5	598.9	9.2
60	268	6.1	37.6	2.6	703.6	1.7
70	207	6.9	40.8	3.9	810.1	1.4
80	164	7.5	42.9	4.9	813.6	
90	133	7.9	44.4	5.6	750.6	
100	116	8.2	45.3	6.1	710.1	

Point of culmination—54 years.

Net total yield at 54 years—644.0 cubic feet.

Mean annual increment at 54 years—11.9 cubic feet.

contain over 60 per cent balsam.

After burning, nature requires from five to thirty years to establish a normally stocked stand on those areas which are not burned too severely for reforestation. After logging, deforestation by insect or fungi, or loss from windfall, an area may be normally stocked with growth to give a second mature stand in less than the full rotation period required for the given species. An example of this more or less normal stocking in immature growth as the mature stands are removed by agencies other than fire is cited above under History. Assuming that the August gale of 1873 removed most of the mature timber of Cape Breton at that time, the mature stands which now average 65 years old must have been more or less normally stocked with immature growth, averaging 8 years old, immediately after the destruction of the mature timber.

On the other hand, if the present dense, even-aged, mature stands of softwood are removed, it may require from two to ten years to produce normally stocked seedling growth. This is true in spite of the fact that there may be fairly dense seedling and immature growth under the mature stands; this immature growth is often windthrown or killed by sun-scorching following logging operations. Following this, there is generally a growth of weeds and brush, mostly raspberries, to work through which, the new tree-seedlings require several years.

On the whole, the average time required for normal restocking following burning might be considered as ten years while, following clean-cutting or deforestation by agencies other than fire, new seedling growth would start immediately. So that, following devastation by agencies other than fire, the average normal rotation period would be as given for each forest type in the yield tables developed, while after burning, the average normal rotation period would be as given in the tables plus ten years.

Yield Tables

The growth in the same forest type and under the same site conditions was found to be somewhat more rapid in some sections than in others, though the growth in various sections of the area examined does not vary very greatly from that in the lower site classes generally differentiated for spruce and balsam in the Northeastern states. Comparison may be made with figures in Bulletin 79, United States Department of Agriculture. A yield table for the softwood forest type in the better of the two classes differentiated on the area examined is presented herewith.

Similar yield tables were made up for the two site classes in each of the two districts in the area investigated

TIMBER TYPES IN THE KIAMICHI AND OZARK REGIONS

By KARL M. STOLLER

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The author describes briefly the forests types in the mountains of eastern Oklahoma and northwestern Arkansas, and offers an explanation of their variations and their correlation with local soil, moisture and topographic conditions.

DURING THE summer of 1930, the writer was a member of a party engaged in land examination for the Forest Service in the Kiamichi region of eastern Oklahoma, and during the following fall and winter was occupied in similar work in the Ozarks of northwest Arkansas. In the Kiamichi, a tract of approximately 110,000 acres was examined; and in the Ozarks, scattered tracts aggregating about 15,000 acres, rather evenly distributed over the central and western divisions of the Ozark National Forest, were covered. Certain characteristic timber types were observed, and these show correlations with the atmospheric and topographic conditions, and with the geological structure and superficial soil composition. It is the purpose of this article to briefly describe the timber types as they exist, and to point out these correlations in explanation of the rather marked variations in forest types.

In both the Kiamichi and Ozark regions, timber types were classified as to height growth or site quality, into lower slope, upper slope and ridge types, corresponding roughly to sites capable of producing mature trees of 3 logs, 2 logs and 1 log in height respectively. These types were subdivided into good, medium and poor quality. Stands were also separated into hardwood and pine types in accordance with the predominating species in the climax type.

The Kiamichi Mountains consist of parallel ranges running approximately east and west, and vary in height from 1,500 to 2,400 feet above sea level. Pine types predominate, the only hardwood types being found in a rather narrow belt on the north slopes and benches of the higher ranges just below the summits.

A typical transect, running from south to north at right angles to the topography across one of the principal east-west ranges of the Kiamichi, would reveal the following timber types: Starting in the valley south of the range and proceeding northward up the south slope, one would pass through a lower slope pine type varying from good to poor quality; then a belt of upper slope pine would be encountered; finally, close to and at the summit of the range, a ridge type pine or pine-hardwood stand would be found. Descending northward, one would encounter poor to good upper slope hardwoods on the precipitous north slopes, frequently followed by a belt of lower slope hardwood type on a narrow bench below. Continuing the descent to the north, upper slope pine would be found, gradually improving in height and culminating finally in a

good grade of lower slope pine as the valley north of the range was reached.

There is thus a distinct correlation between elevation and site quality, which, however, is modified by other factors such as exposure, topography, soil depth and soil composition.

The south slopes of the parallel ranges of the Kiamichi are exposed to the rays of the sun much longer than the north slopes, particularly those portions of the north slopes not far below the summits of the ranges. The south slopes thus suffer from lack of moisture, which condition becomes more acute as one ascends. The soil, too, becomes thinner towards the summits of the ranges, and is nearly always rocky with occasional barren areas of exposed bed rock.

The north slopes near the summits are precipitous and rocky with occasional rock slides. Below these slopes narrow benches often occur. These slopes and benches are relatively well provided with moisture due to the northerly exposure being shaded from the sun a large part of the time by the precipitous slopes above. This moisture condition has enabled the hardwood types to crowd out the pine type in these relatively limited belts or zones, and accounts for the existence of a lower slope hardwood type at an elevation above that of the upper slope pine type on the north slopes of the ranges. Below this hardwood zone, the slope becomes more gentle and exposed for longer periods to the sun's rays, hence the soil is drier, and here the pine type overcomes hardwood competition.

It is also true that the higher north slopes have a lower average temperature than the lower elevations and south slopes, and hence have a climate comparable to the central hardwood rather than the Southern Pine region.

In the Ozarks, we have distinctly a hardwood region, such pine types as do appear invariably occur on the south slopes and for the same reason as on the Kiamichi. These pine type areas are, however, very limited in extent. Likewise the north slopes show a distinctly superior height growth indicative of soil moisture and temperature conditions better adapted to the hardwood type than the drier south slopes, which are capable of supporting only the more xerophytic hardwoods and occasionally pine. The easterly and westerly exposures are also predominately hardwood sites, although more or less inferior in site quality to the north slopes.

The summits of the Ozark Mountains are invariably flat plateaus, and here one frequently finds soil of sufficient depth, fertility and moisture content to produce a fair growth of lower slope type hardwoods while on the slopes immediately below, particularly the southerly slopes, one frequently finds upper slope hardwoods and occasionally a few pines. Then again lower down the slopes, especially on the northerly exposures, rather wide fertile benches watered by springs occur where stands of excellent lower slope type hardwoods appear.

In the Ozark region, the geological structure is an important factor in determining the timber types. The existence of flat topped plateaus and benches, as well as frequent low bluffs of precipitous to vertical or even overhanging rocks, are features which are

the result of the erosion of a vast sandstone plateau in which the rock strata are nearly horizontal, and the layers vary in resistance to erosion. These features play an important part in the distribution of moisture, which is a prime factor in determining the timber types present.

In contrast to the Kiamichi, the Ozark region is in the main well watered, with numerous springs emerging near the base of the sandstone bluffs and mountain slopes. This is explained by the stratified condition of the rocks in the Ozarks as contrasted to the highly metamorphosed bed rocks of the Kiamichi. This, together with the generally high altitude of the country, frequently in excess of 2000 feet above sea level, and the slightly more northern latitude and somewhat heavier rainfall, combine to make the Ozarks predominately a hardwood country, while the Kiamichi is predominately a pine region.

Early English Foresters

"A forester is an Officer sworn to preserve the *Vert*[1] and *Venison* in the forest, and to attend upon the wild Beasts within his Bailiwick; and to attach Offenders there, either in *Vert* or *Venison*, and to present the same at the Courts of the Forest, that they may be punished according to the Quantity and Quality of their Offences and Trespasses."

THE OATH

"You shall truly execute the Office of Forester, or Keeper of the King's wild Beasts within the Forest. You shall be of good Behaviour yourself towards his Majesty's wild Beasts, and the *Vert* and *Venison* of the same Forest; you shall not conceal the Offence of any other Person, either in *Vert* or in *Venison*, that shall be done within your Charge, but as well the same Offence, as also all Attachments you shall present at the next Court of Attachments, which shall first happen to be holden for the same Forest; and you shall to the uttermost of your Power maintain and keep the Assise of the Forest, and in all Things the King's Right defend concerning the same, so long as you shall be Keeper there: So help you God."

From Manwood's *Treatise of the Forest Laws*, London, 1717.

[1]*Vert* signifies *greenness*.

FOREST VEGETATION IN SOUTHEASTERN NEBRASKA

By A. E. HOLCH

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Analysis of a census of trees, shrubs, and vines conducted by the author on sample areas in southeastern Nebraska and reported here indicates a denser tree population on the moister sites but a thinner population of shrubs and vines.

THE PLANT CENSUS described in this paper was taken in the low bluffs bordering the Missouri river in southeastern Nebraska. Much of this territory was cut over about 60 to 70 years ago, but has again become a wooded area with the more mesic trees, such as basswood and ironwood, occupying the lower well drained habitats, and the more xeric ones such as bur oak and black oak growing well up on the hillsides. Such species as shellbark hickory and red oak dominate the intermediate territory.

The method used in the study was a modification of the transect method familiar to the ecologist. From a common point as a center eight tapes one hundred feet long were stretched out into the forest, making eight quadrants of forty-five degrees. The trees, shrubs, and vines were then determined and counted in each quadrant, and the counts for the eight quadrants added to obtain the totals. Each of the circular areas studied included 0.72 acre. No count was made of trees under six feet in height, shrubs under three feet in height, or vines under five feet in length. Three such counts were made, one in the forest low on the hillside dominated by the basswood, another toward the top of the hill in the bur oak woods, and the third in an intermediate location where the red oaks prevailed.

Table 1 gives a summary of this census of the vegetation in the three habitats.

In the bur oak forest, bur oak (29 trees) and black oak (40 trees) constituted the dominant forest element. Many of them were 15 inches in diameter. Basswood was represented only by three small specimens and red oak by five. The 36 red elms were very small trees, as were also the 5 white elms, 4 yellow oaks, and 4 wild black cherries.

In the forest on the moist but well-drained slope just above the ravine, basswood was dominant, represented by 64 trees, many of which measured 16 or more inches in diameter. Ironwood constituted an extensive and characteristic understory. There were 14 red oaks well up on the slope, and 9 each of bitternut hickory, yellow oak and bur oak. *Ulmus* was well represented by 85 white and 31 red elms. Red mulberry, white ash, and redbud were prominent.

The species of both the basswood and the bur oak forests mingled somewhat in the intermediate red oak woods. Here the soil was neither very wet as in the basswood forest nor relatively dry as in the bur oak forest. Likewise the shade was not as severe

TABLE 1

CENSUS OF TREES, SHRUBS, AND VINES IN THREE HABITATS IN SOUTHEASTERN NEBRASKA

Species	Number in basswood forest	Number in red oak forest	Number in bur oak forest
Species of trees			
Red oak (*Quercus rubra*)	14	15	5
Linden (*Tilia americana*)	64	86	3
Bur oak (*Quercus macrocarpa*)	9	24	29
Black oak (*Quercus velutina*)	9	27	40
Yellow oak (*Quercus acuminata*)	3	1	4
White elm (*Ulmus americana*)	85	11	5
Red elm (*Ulmus fulva*)	31	53	36
Hackberry (*Celtis occidentalis*)	0	2	0
Bitternut (*Hicoria minima*)	9	3	0
Honey locust (*Gleditsia triacanthos*)	0	1	0
Red mulberry (*Morus rubra*)	34	4	0
Wild black cherry (*Prunus serotina*)	2	2	4
Ironwood (*Ostrya virginiana*)	163	0	0
Box elder (*Acer negundo*)	1	0	0
White ash (*Fraxinus americana*)	41	0	0
Red bud (*Cercis canadensis*)	15	1	7
Cottonwood (*Populus deltoides*)	1	0	0
Total	481 (65 sq. ft. per tree)	230 (136 sq. ft. per tree)	133 (236 sq. ft. per tree)
Species of shrubs			
Dogwood (*Cornus asperifolia*)	18	246	466
Prickly ash (*Xanthoxylum americanum*)	9	116	211
Blackberry (*Rubus nigrobaccus*)	0	137	8
Sumac (*Rhus glabra*)	1	88	198
Choke cherry (*Prunus virginiana*)	0	1	36
Alder (*Alnus glutinosa*)	0	2	3
Raspberry (*Rubus strigosus*)	5	56	106
Gooseberry (*Ribes missouriensis*)	0	2	0
Plum (*Prunus americana*)	0	2	0
Coral berry (*Symphoricarpos symphoricarpos*)	0	8	2
Elderberry (*Sambucus canadensis*)	0	5	0
Rose (*Rosa setigera*)	0	1	0
Burning bush (*Euonymus atropurpureus*)	3	0	0
Hazel-nut (*Corylus americanum*)	29	0	0
Total	65 (483 sq. ft. per shrub)	561 (56 sq. ft. per shrub)	1030 (30 sq. ft. per shrub)
Species of vines			
Bittersweet (*Celastrus scandens*)	53	41	217
Poison ivy (*Rhus radicans*)	41	42	108
Wild grape (*Vitis vulpina*)	18	32	25
Woodbine (*Parthenocissus quinquefolia*)	11	34	3
Hop (*Humulus lupulus*)	0	2	0
Wild smilax (*Smilax hispida*)	0	28	27
Total	123 (255 sq. ft. per vine)	179 (175 sq. ft. per vine)	380 (82 sq. ft. per vine)

as in the basswood forest nor as light as in the bur oak area. Fifteen red oaks were by far the largest of the trees and the most prominent feature of the vegetation. Eighty-six small lindens and 64 fair-sized elms showed the possibility that these species might eventually become important in the territory. Bur oak was represented by 24 specimens and black oak by 27, but most of these were very small trees.

In the drier habitat on the upper hillside there were 236 square feet to each tree. This average was cut to 136 square feet in the more mesic red oak woods and to 65 square feet in the moist basswood forest, where the tops of the trees interlocked to cast almost continuous shade. The relatively greater distances between trees in the drier habitat on the upper hillside resulted in approximately three times as much light reaching the forest floor as compared with the basswood forest (3.3 per cent in the basswood and 11.7 per cent in the bur oak). This gave shrubs and vines a better opportunity than in the heavy shade of the basswood forest. In the latter there was 483 square feet for each shrub and 255 square feet for each vine while in the bur oak woods the sequence was 30 and 82 square feet respectively. The red oak forest was again intermediate with 56 square feet for each shrub and 175 square feet for each vine. It appears, therefore, that the lesser amount of moisture in the soil on the upper hillside results in a considerable reduction of the total number of trees but in a corresponding increase in the number of shrubs and vines. Conversely, the soil in the forest low on the hillside contains so much moisture that it supports a correspondingly greater number of mature trees, but these cast such a dense shade that the number of vines and shrubs is reduced almost to nothing.

The writer appreciates the fact that in some parts of the United States these soil moisture relations may be reversed and the smaller moisture content associated with the area bearing the greater number of trees. However, in the territory studied in southeastern Nebraska, soil moisture determinations made twice a week through three different growing seasons showed conclusively that the greatest amount of moisture was always found in the densely tree-populated basswood forest, and the least moisture in the sparsely populated bur oak forest, with the red oak forest intermediate.

WOODS AND FOREST BOTANY AT FIELD MUSEUM OF NATURAL HISTORY

By L. WILLIAMS

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The Field Museum in Chicago has for several years been rearranging and augmenting its exhibits of trees, woods and forest products. Specimens of trunk, foliage, fruit and wood are included. The collections, already the best in the United States, are of inestimable educational value to those interested in forests and their products of both North America and other continents.

FIELD MUSEUM was founded in 1893 by the late Marshall Field who contributed the sum of $1,000,000 for the purpose. Subsequently, at the time of his death, he bequeathed an additional sum of $8,000,000. Such munificent gifts and the whole-hearted support given by Mr. Field assured at the outset the success and permanence of the newly-formed institution. Other contributors promptly appeared and a spirit of generous coöperation was aroused.

From the beginning, authorities of the Museum realized that the science of botany is one of the principal divisions of natural history. Thus, for the first time in the United States, a general natural history museum devoted to botany attention comparable with that given other subjects.

The funds donated by Mr. Field and other prominent citizens enabled purchases to be made of large collections or important gifts that had been displayed at the World's Columbian Exposition held in Chicago in 1893. Such acquisitions included entire exhibits of timbers representing the United States, Japan, Russia, Australia, India as well as various republics of Central and South America. These and other raw plant material along with economic plant products, donated by various governments at the conclusion of the exposition, formed the nucleus of collections for a department of botany. A herbarium was established and collections began to increase.

In the course of time, officials of the Museum, then known as Field Columbian Museum, considered the advisability of expanding the collection of timbers. Expeditions were undertaken as early as 1894 by the late Dr. C. F. Millspaugh, then Curator of the Department. At frequent intervals during the period 1902 to 1912 intensive field work was conducted by members of the staff, especially Mr. Hurin H. Smith, to various parts of the United States for the purpose of securing authentic material to be used in making an elaborate display of the forest resources of this country.

In most instances the plan followed was to select a tree in the open where it could be photographed readily and the entire exhibit and herbarium specimens taken from the same tree—a method distinctly advantageous in many respects, although not always furnishing a typical quality of lumber. A great mass of material was brought together in this manner and as soon as complete collection was made of a

species the specimens were prepared for exhibition and installed to inaugurate a series illustrating North American forest trees.

In 1912 the Museum took possession of its new building on the lake front. It was soon realized that the space allotted to American woods could not possibly suffice for a complete series on the scale originally planned, and the necessity of revising the program, omitting from exhibition the less important woods, became evident. About six years ago the Department of Botany engaged the services of Professor Samuel J. Record of Yale University as the Museum's Research Associate in Wood Technology, to undertake the task of formulating a revision of the plan for the exhibits of North American woods displayed in Charles E. Millspaugh Hall.

A great mass of unimportant material was eliminated in order to provide adequate space for those species regarded as being of greater importance. The work of reinstalling the exhibits began early in 1929 and through the generous coöperation of several individuals and lumber concerns who have furnished necessary material, the display is now nearing completion. Every effort has been made to show wood typical of the species, preferably at its best. The chief species required to complete the display on the reduced scale adopted were the western trees which are now important factors in the trade of the entire country. Earlier collecting had not included all of these and to secure them the Museum sought the aid of various concerns and individuals. Among those who have actively aided in obtaining new and more representative exhibit specimens mention should first of all be made of Professor Emanuel Fritz of the University of California who has made contributions and rendered valuable assistance by soliciting material among various lumber concerns, especially those operating on the Pacific Coast. Assistance has also been given by the West Coast Lumbermen's Association and the National Lumber Manufacturers Association. The United States Forest Service has provided several photographs of trees that were not in the Museum's files.

New Installation of North American Trees

The exhibits have been restricted to eighty-four species and most of these were selected on the basis of the economic value of the trees for their lumber. Others of less importance, such as Osage orange and Monterey cypress, have been included to provide a conception of the wide variety of trees native to this country. In making the installations it was deemed advisable to arrange the species according to natural groups or botanical relationships. The series may thus be considered to begin with the conifers. The exhibition cases measure seven feet high inside, twelve feet wide and from eighteen to thirty inches in depth, painted buff color, and one case generally affords space for two species. Each tree is represented in a standardized manner by a trunk about five feet tall, and from six to thirty inches in diameter, with the bark in place; a wheel-section corresponding in diameter to the log

ıd cut through to the center to prevent irregular cracking due to shrinkge; and one to four boards, depending on their width, from one to one nd a half inches thick and up to ıe full height of the case in length. sually some of the boards are quarred and others flat-sawed to show ariation in figure. To prevent unven drying and cracking with loss of ark, the trunks have been slab-sawed nd the center rejected. In the case of ıe larger species, especially western oods, which could not be accomoated entire due to limited depth of ase, one or two slabs had to be mitted and the remaining ones reasembled and placed in a corner of the ase. In this manner it has been posible to provide a conception of the elative size of the species.

Each installation is supplemented by hotographs of a branch with leaves, ruit or flowers; also photographs of ıe tree (in the case of deciduous species showing summer and winter conition), thereby presenting an idea of he species as it appears in its natral state. The range of each and the articular region where it is especially lentiful are outlined on a map. A abel bearing a brief description of he tree, the principal physical characeristic of the wood, its chief uses and ther essential information, completes he installation.

In some instances the exhibits will e improved by the inclusion of ceran special products. Woods notably vell adapted for a particular purpose, uch as persimmon or dogwood for veaver's shuttles or paper birch for pools, may receive the addition of uch objects. In one case, that of pignut hickory, the photograph of the foliage has been replaced by a reproduction of a fruiting branch, and it is expected that in course of time all the photographs of branches will be supplanted in such manner.

Several species are still lacking, notably pondosa and Idaho white pine, holly, and others. Efforts are being made to secure suitable specimens of these and the material will be installed as soon as it becomes available.

Hall of Foreign Woods

Mention has already been made of the exhibits of foreign woods donated to the Museum by the governments of various countries at the termination of the World's Columbian Exposition. In 1904 these collections were augmented by Japanese specimens which had been on exhibition at the St. Louis Exposition. Further contributions were made in 1912 by the Philippine Bureau of Forestry which donated a number of panels of Philippine woods. In 1915 there were received a series of planks representative of the principal woods of Argentina from the Argentinean Commission of the Panama-Pacific Exposition.

These donations formed the basic of a collection which was eventually placed on display in a hall reserved for the exhibition of foreign woods.

The North American wood hall having reached a stage approaching completion, attention is at present being given especially to the hall of foreign woods. It is naturally impossible to show all woods of every foreign country and attention is first of all being given to the representation of those

that have assumed commercial importance in the United States.

The exhibits are arranged according to the countries of their origin—those of the eastern hemisphere occupying one half of the hall and woods of the western hemisphere confined to the other half. Installed in cases similar to those used in the hall of North American woods the specimens are shown in the form of boards of veneered panels. All the specimens are left in their natural state, no filler, stain or painter's finish being permitted. In the case of the more important species, such as mahogany, walnut, and others, several specimens of each are displayed for the purpose of illustrating distinct types of color and figure.

To secure new material the Museum has found it necessary to solicit the coöperation of various importers and manufacturers who specialize in foreign or tropical woods. Valuable assistance obtained has resulted in the acquisition of a number of African, Indian and European woods hitherto not represented in the collection. Other woods, little know or not readily procured on the market, have been obtained as opportunity offered in connection with botanical expeditions. A set of twenty-five of the principal species of the lower Amazon Valley, utilized in the local wood-working industries, was brought back by a recent Museum expedition and these have already been installed as representative of that region. However, a number of countries exporting large quantities of lumber to the United States are still unrepresented.

Each specimen exhibited is accompanied by a label bearing a concise description embodying information regarding the size of the tree, its distribution, physical characteristics of the wood and its uses, and any other information of general interest. In some instances photographs are used to show the appearance of the species in its natural habitat.

The wood exhibits of the Museum have a manifold utility and serve to meet the requirements of individuals seeking definite information on the properties and characteristics of these various woods with a view to some specific use as well as bridging a gap between the scientific specialist and the casual visitor to the Museum. To perform its mission of disseminating knowledge such an institution as Field Museum demands the highest standard of accuracy in its exhibits as well as in its research activities, and no effort is spared to make the installations authentic and at the same time attractive in the presentation of their subjects.

Other Forest Products

Two other halls of the Department are devoted almost entirely to plant economics. In one of them are found wood distillation products, rosin and turpentining methods, rubber and resins, paper pulp products, cork, tanning materials, dyewoods, lacquers, etc. Part of the other hall is occupied by exhibits of food products of vegetable origin, starches, sugars, vegetable oils and fats, tea, coffee, spices, etc. The other half is devoted to an extensive display of palms and their varied products, an unusually fine collection resulting mostly from Museum

expeditions to tropical countries.

The fifth and largest hall, called the Hall of Plant Life and extending the entire east side of the building, is occupied by exhibits designed to furnish a general view of the vegetable kingdom and is undoubtedly one of the finest collections of its kind in existence. The problem of producing a satisfactory and lasting display of plants has been solved by the preparation of reproductions which are exact replicas of the living specimens. These are the work of the Stanley Field Plant Reproduction Laboratories, maintained in the Museum through the generosity of Mr. Stanley Field, President of the Museum. Among especially noteworthy exhibits in this hall are the flowering and fruiting top of a coconut palm and the flower-bearing trunk of the unique cannon-ball tree of British Guiana. In addition there may be seen flowering and fruiting branches of many of the forest trees of North America and of foreign countries.

Another Museum exhibit of considerable interest to readers of the JOURNAL OF FORESTRY is a recently completed restoration of a section of a swamp forest of the Carboniferous Age, a contribution of the Department of Botany to the historical geology series. This is based largely on fossils discovered at Mazon Creek, Illinois and represents the first serious attempt ever made to re-create in three dimensional form an assemblage of the flora and fauna of the Pennsylvanian Period, thus producing an actual reproduction of a scene in a forest of the Paleozoic time. Among the trees that constitute the forest of that period are found the earliest of known gymnosperms. The remainder were mostly gigantic clubmosses, horse-tails, ferns and fernlike seed plants—"seed ferns," now entirely extinct and replaced by flowering plants. The trees had many striking features distinguishing them from those of the present day, such as a slender primary core, a large pith cavity and a small amount of wood, although most of them, even the ancient horsetails, possessed a cambium and increased in size by continuous diameter growth. Absence of growth rings was probably due to the uniformity of the climate prevailing at that time. The restoration was made under the supervision of Dr. B. E. Dahlgren, Acting Curator of the Department.

EXPEDITIONS

During recent years the Museum's wood and other collections have been greatly enriched by the results of expeditions conducted by members of the Department of Botany. Valuable material, especially from Central and South America, for study and exhibition purposes has been obtained by systematic collecting.

In 1922 the Stanley Field Guiana Expedition made botanical collections, including palms, in the region of Georgetown, British Guiana. In continuation of this work, the late Mr. A. C. Persaud was employed to secure wood and herbarium specimens during a part of 1923 and 1924.

Due to the absence of authentic material from the Amazon Valley the Marshall Field Amazon Expedition, in charge of Dr. Dahlgren, assembled a representative series of the principal

FIG. 1.—A typical installation showing trunk sections, sample boards, reproductions of foliage and fruit, and photographs of the species in summer and winter conditions. In this instance the boards are defective and will be replaced with sound material as it becomes available.

woods and other specimens occurring in the forests of the lower Amazon.

Another division of this expedition, with the writer in charge, spent over twelve months, during 1929 and 1930, making collections in northeastern Peru. The material brought back included over 2,000 samples of woods with corresponding herbarium material in addition to other botanical specimens and economic products of that region. These specimens form a desirable addition to the collections brought together by Mr. James F. Macbride, a member of the staff, during two previous expeditions to central Peru.

By means of these explorations much useful information, such as size and abundance of trees, local uses of the wood, and various other information of value has been obtained. It is only by making collections of woods accompanied by respective herbarium material, especially of new or undescribed species, that one can be certain of the identity of the wood specimen, which, if not referable to its proper genus or species, is worthless for scientific purposes.

Study Collections and Research

The Museum possesses a study collection of approximately 10,000 wood samples which provides authentic material as well as forming a basis for research. These specimens have been obtained from various countries by expeditions, gift, exchange, or purchase and are of varying sizes, although the standard adopted by the Museum is six inches long, four inches wide and three-quarter inch thick. Duplicate sets of some of these have been distributed to various institutions especially those collaborating under the auspices of the International Association of Wood Anatomists.

The collection of wood specimens from northeastern Peru is now being studied by a member of the staff and the results of these investigations will be published as soon as all the determinations have been made.

The determination of woods goes hand in hand with the work of the systematic botanist and both are largely dependent upon the availability of a good herbarium. Organization of a large herbarium for the Department of Botany was begun immediately after the establishment of the Museum and this adjunct has rapidly increased in size and scope. At the present time it consists of 660,000 mounted sheets of plant specimens and is especially rich in plants of tropical America. The series of Peruvian and Yucatan plants is unexcelled.

During the last few years most of the material obtained from those regions has been determined by Mr. Paul C. Standley, Associate Curator of the Herbarium, and every year thousands of specimens are named for investigators in other institutions, both in this country and abroad. Most of the tropical American plants collected for the Yale School of Forestry are determined by Mr. Standley. Mr. James F. Macbride, Assistant Curator of Taxonomy, has been engaged for several years in studying the flora of Peru, basing his researches on material collected by him during 1922-1923 and subsequent expeditions.

In 1929 Field Museum began a task of great importance to systematic

botany, especially that of Central and South America. For some years past the Museum has maintained a member of the staff for the purpose of photographing type specimens of plants in the herbaria of Europe. This work is financed jointly by the Rockefeller Foundation and Field Museum. When the photographs are available systematic work in American herbaria will be greatly faciliated in respect to tropical American plants.

Early English Forest Rangers

"Because the *Purlieus* were once Forest, and great store of Deer and other wild Beasts continued there after they were disafforested; therefore it was very necessary for the King to have some particular Officers there, to have a care to preserve the wild Beasts therein.

"Therefore immediately after the disafforestation, there were certain Officers appointed for that Purpose called *Rangers*, who are not Officers of the Forest, to take charge of the *Vert* (growing trees); but they are Officers of or to the Forest, tho' not within the Forest, and they have no charge of the *Vert*, but only of the *Venison* which cometh out of the Forest into the Purlieus (environs), and which they are to drive back again without destroying the same.

"A *Ranger* is made by the King's Letters Patent, who alloweth to every one of them a yearly Fee or Pension of 20 or 30 £ payable out of the *Exchequer*, and a Fee-Deer, both red and fallow, out of the Forest."

From Manwood's *Treatise of the Forest Laws*, London, 1717.

FORESTRY IN THE MUSEUM OF SCIENCE AND INDUSTRY

By HELMUTH BAY

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Not many Americans outside of Chicago know that there is building in that city a great museum to depict the progress of industry. Considerable space will be devoted to forestry and lumbering, and it is fortunate that the Museum has obtained a man to plan and direct the acquisition and installation of suitable exhibit material who knows both forestry and the forest industries from training and experience. Mr. Bay tells in this article what he has planned. Many of the models are already completed.

IT SHOULD be of particular interest to American foresters and lumbermen to learn that in the Museum of Science and Industry, which is being established in Chicago, considerable space will be devoted to an exhibit of the history, development, and present-day practices in forestry, lumbering, and the manufacture of forest products.

The idea of such an industrial museum was conceived by Julius Rosenwald of Chicago, in 1926, on his return from an extended tour of study and observation in Europe. Struck by the fact that the United States, in spite of its achievements in science, engineering, and industry, possessed no institution wherein the record of its accomplishments could be visualized, he broached his plan to the Commercial Club of Chicago, offering to endow such a museum with $3,000,000 to be spent for equipment alone. The club received Mr. Rosenwald's proposal with great enthusiasm and immediately formed a board of trustees and a committee of administration. The city, awake to the situation, responded by authorizing the South Park Commissioners to reconstruct the old Fine Arts building, an architectural masterpiece dating from the World's Columbian Exposition. In this structure, containing about nine and one-half acres of floor space, the collections are to be exhibited, and it is hoped that by 1933 the visual explanations of industrial progress will be sufficiently far advanced to permit public inspection.

In considering the economic and industrial activities connected with forest utilization from the standpoint of visual education in the Museum, it was deemed advisable to divide them into six principal subdivisions, namely:

Forest Management
Logging
Sawmilling
Woodworking
Tropical and Foreign Forestry
Special Forest Products

The first group, forest management, which embodies all the principles of handling woodlands, properly begins with a description of the resource itself,—the raw forest materials upon which the various activities of the lumber industry depend. What could be more fitting, therefore, than to introduce the subject of forestry by a series of pictures of various kinds of forests? People who have heard or read about our wonderful white pine forests, our "big trees" of California, our beautiful hardwood forests, the majestic splendor of the Douglas firs,

and the rain forests of the tropics, cannot hope to visualize the timberlands by merely a word picture, so in line with this thought we shall display around the entire hall, in the form of a border, sixteen or twenty large, colored photographs of principal forest types.

The next series of exhibits which the visitors will see constitutes an explanation of the methods of forest mensuration, and, as an aid to their elucidation, we shall have a collection of hysometers, dendrometers, calipers, tree tapes, increment borers, scale rules, and other instruments. A sufficient number of these instruments will be available for handling or for demonstration by the guide, while the manipulation of others will be restricted to students and to those particularly interested in this branch of forestry who may secure permission to try them out in the park which surrounds the building. (I might mention that our collection of scale rules, which now contains one of practically every rule ever devised in the United States, is the only collection of its kind in existence.) The practical use of the measurement data secured through timber "cruises" and estimates will then be explained by an exhibit on forest mapping which will also include aerial forest mapping.

When the timber stand has been investigated and a thorough knowledge of the topography and the contents of the forest has been obtained, operators must decide on the cutting plan. The time when lumbermen went into the forest and cut everything clean without any thought or regard for future generations is practically over. Silvicultural systems of cutting, in which reforestation and fire protection play important rôles, have been adopted by many of the large timber operators and enthusiastic discussions of their methods may be found almost regularly in leading lumber journals. So next will be seen a brief diagrammatic explanation of a few of these silvicultural systems, after which the visitor's attention is directed to reforestation.

The extraction of seed and its preparation for the nursery may be studied by means of operating models of seed extracting devices. Adjacent to these will be a number of actual seed beds illustrating the manner in which seedlings are cultivated in the nursery, and in conclusion the tools and implements employed in planting, together with transparencies showing field operations.

With the young forest under way, our next problem is to protect it, and due to the fact that forest fires destroy not only immense amounts of merchantable timber, but also so much potential forest every year, the phase of fire protection will be accentuated. In addition to aiding a cause upon which the very existence of American forest cover hinges, and upon which the solution of such serious problems as flood control and erosion depends, the dramatic possibility in presenting the forest fire picture is practically unlimited. Consequently, all of Hall B has been set aside for an explanation of the detection, suppression, and effects of forest fires.

Situated in the center of this hall, upon an elevated base, will be the replica of a lookout station on one of the western mountain peaks. Surrounding the station, on the upper portion

of the wall, will be a painted panorama, and on this the occurrence of forest fires will be simulated by means of light effects. The visitor may then observe them with the fire finder in the lookout station and locate them on a map, thus going through the actual process of fire detection. The corners of the hall and the space beneath the lookout station will be devoted to a collection of pumps, flame throwers, tools, and equipment used in fire suppression, an automotion picture of fire fighting, a diorama illustrating the trenching operation, an exhibit arranged by the U. S. Forest Service, a map showing the protection system on a National Forest, and an alcove containing miscellaneous exhibits depicting fire effects, statistics, and the like. By means of this dramatic spectacle we shall not only be able to give the visitor a perfect demonstration of the actual methods of forest protection but we shall also have an opportunity to aid in solving one of the greatest public educational problems of the period—the prevention and control of forest fires.

Next in the forestry sequence comes the subject of logging, an activity of tremendous size and variation which involves the use of much large machinery and the application of numerous principles of engineering. It is planned to finish the walls and ceiling of Hall C, in which logging exhibits will be displayed, with peeled logs, giving it the appearance of the interior of a huge log cabin—creating an atmosphere well suited to its contents. In the four corners of the hall dioramas will be constructed, each one depicting a certain method of logging, historical or modern, and each typifying operating practices in a particular region of the United States. These dioramas are essential to giving a conception of the use of the large mechanical devices used in logging—devices that are but parts of an operation and which do not tell the neccessary story or teach the required lesson when displayed simply as unit exhibits.

As an aid to visualizing such a diorama I will attempt to describe one of them which I have named "Winter Logging in the Northeast." The background will be a typical scene as it appears in the logged-over area of the northeastern pine region during the winter. A logging camp may be seen in the distance on the right. In the foreground a crew of men are engaged in loading logs on a set of sleighs by means of a horse-jammer, the logs being taken from a deck or log-storage pile of which several are shown. On the left a load is making its way to the landing while a returning empty sleigh stands in a turnout of the road. Near a small ice-covered stream in the right foreground you see a road-sprinkler, completely rigged and ready for filling, and close by one of the snowplows of the rutter type used in cutting ice roads. The diorama will be constructed on a scale of 1 to 24 with every detail as perfect as possible. The positions of the men and implements will be such that every action and every operative principle is clearly demonstrated and thus we shall be able to relate a story which in actuality covers acres of ground and involves huge mechanical devices.

Supplementing the four dioramas will be as many large logging implements

and as much actual equipment characteristic of the industry as space permits. Among the items included are a dray, a set of Michigan "big wheels", a "lizard" or crotch-shaped transportation device from the South, pike poles, peavies, cant hooks, sleigh rigging, chains, a go-devil or bummer, and numerous other items many of which are historical in nature. Along one side of the hall there will be a working model of the high lead set-up, flanked by transparencies the motion pictures illustrating its operation.

The development of the saw and the axe will also be depicted, the evolution of each from a crude stone implement to the modern efficient tool, while on a great panel on the wall there will be a display of axe and saw patterns from all sections of the world. Another interesting phase which will be demonstrated by means of a small semi-diorama is the felling of trees from springboards, a practice much used in the West. It is also planned to have models of some of the famous types of logging-camps of the past such as the "State o' Maine" camp, the "two-ender", the "scoop roof", and others.

On the ground-floor the Caterpillar tractor may be seen in motion, its usefulness emphasized by transparencies and photographs. Near-by an operating model of the Heisler locomotive explains the efficiency of the geared type of locomotive and its advantages to logging. A series of models will illustrate the construction of log flumes, log chutes, and the driving dam, while a set of pictures above them will indicate their relation to their respective operations. And, as a concluding display, there will be a number of working models of the transportation devices used in modern logging, together with some of the large high lead blocks, chokers, skidding pans, and other miscellaneous implements employed in the Northwest at the present time.

After timber has been cut and transported to the mill, it is sawn up into lumber, dried, and stored. So, in line with our sequence, we take up the phases of sawmilling in Hall E and the remaining portion of Hall D. Here the evolution of the sawmill will be explained by a series of operative models among which are such specified types as an ancient man-tread-power sawmill, a 16th Century animal-power sawmill, an early type of water-power sawmill, an early circular sawmill, the first American band sawmill, modern circular and band sawmills, and a gang saw. By means of a large map the historical movement of sawmilling will be traced across the United States. There will also be a log platform on which the operation of "pitsawing" may be attempted, and a collection of modern mill saws. A small side room on the north side of the hall has been allotted to an exhibit on lumber grading. Here the measuring of lumber with a lumber rule as well as the factors that determine lumber grades in principal, the commercial woods will be demonstrated. The next display is devoted to mill yard practices,—seasoning, drying, and the storing of lumber. A model dry kiln of which the top and one side is covered with glass will vividly display the motion of the air in a forced draft kiln. Adjacent to it the kiln-boy, an instrument recently developed which automatically

controls the temperature and moisture in a kiln, may be seen in operation.

Up to this point we have been concerned principally with the acquisition of timber and its conversion into lengths and sizes which may be easily handled and transported. We now begin the final mechanical steps which consist of manufacturing it into the numerous and varied products which we use in our daily life. There are three principal phases in the process of re-shaping or re-working wood—turning, planing, and resawing. Each of these is individually and completely treated in Hall F by means of replicas, actual machines, and other representative displays.

The development of wood turning is explained by a series of four replicas of ancient lathes and one modern lathe, all of which will be capable of operation. These consist, in the order of their development, of the bow-lathe, the pole lathe, the great wheel lathe, the mandrel lathe, and a modern wood-turning lathe.

Planing is illustrated by means of pictures, ancient tools, early hand planes, and an operating shop planer. Resawing begins with the sawing processes, as practiced by the ancients, and carries one through to the present era by means of replicas of ancient shop saws, models of early sawing machines, and modern shop saws.

Closely associated with these three activities are the woodworking shops, a vivid picture of which will be given in Hall G. Here one will see the shops of ancient Egypt, of the Roman civilization during which such great progress was made in the development of woodworking tools, the American shop of the early 19th century, and a modern woodworking establishment. As a part of the latter there will be displayed a number of highly efficient automatic lathes and shapers of the present day—all in operation, a fitting conclusion to the display of mechanical processes of wood utilization.

Preparatory to taking up the studies of the manufacture of individual special forest products, the visitor will pass through Hall H, devoted to foreign and tropical forestry. In this space it is planned to show all special forestry material obtained from foreign countries in general, and phases connected with uncommon forms of forest utilization in the equatorial regions. In addition, two dioramas have been specified, one on teakwood logging with elephants and another depicting mahogany logging, two operations that are more or less known to the public. Tropical forests resources are, in addition to being of considerable interest, intimately connected with the manufacture of special products, so the exhibits in this group form an excellent introduction to the next hall on special forest products.

The space in Hall I has been divided into a number of alcoves, varying in size from ten to forty feet in width, in which will be shown the processes and operations connected with the manufacture of such well-known products as cork, rubber, veneer, charcoal, maple sugar, wood-carvings, wooden shoes, pencils, matches, and miscellaneous items, each individual display to be complete within itself. For instance, rubber will begin with the discovery of the substance and will depict, in order, the various steps necessary to

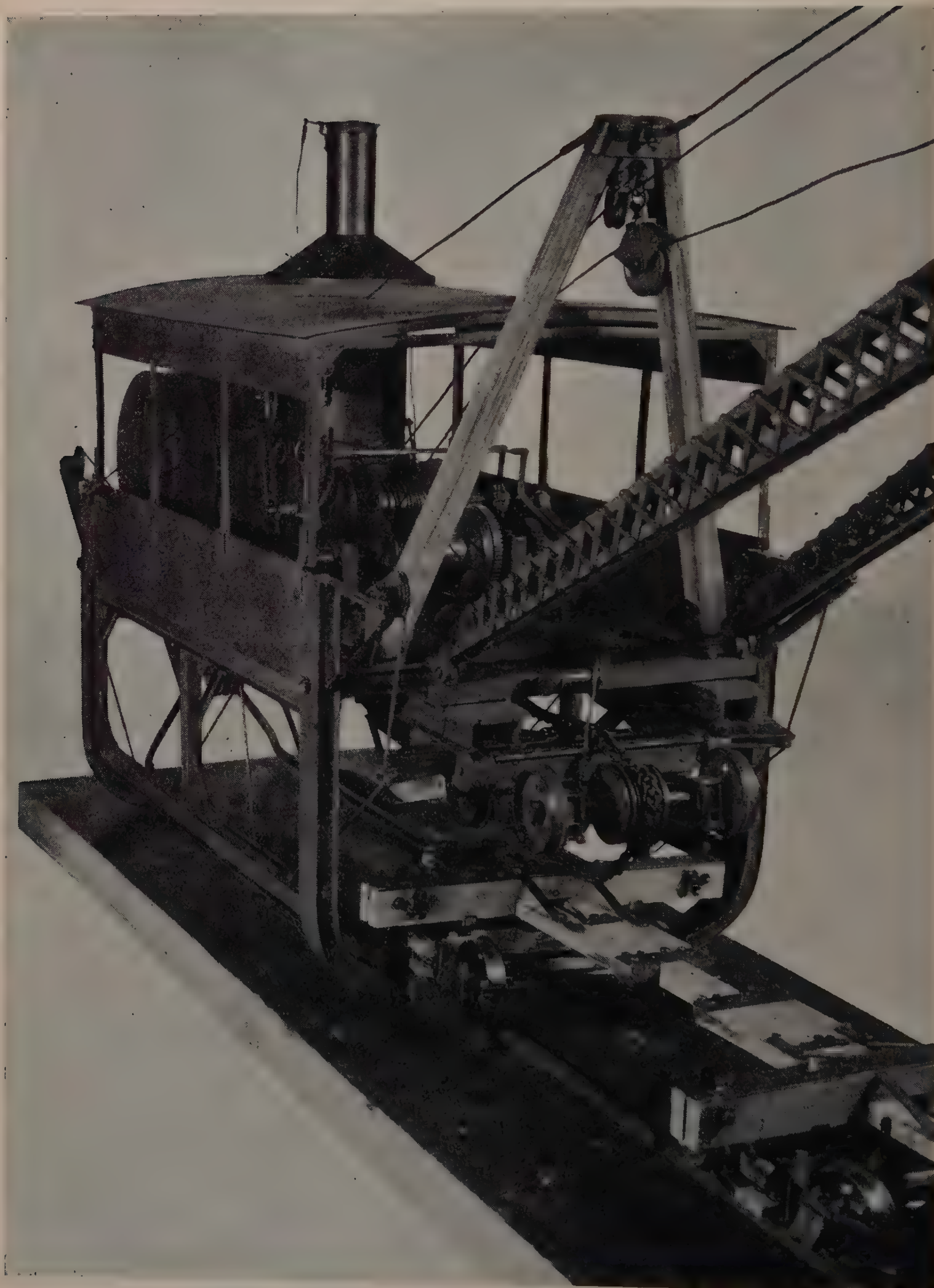

FIG. 1.—Operating model of a McGiffert loader and log car. It illustrates the attention paid to detail to make this and other models accurate replicas of the actual machines. Made from the manufacturer's blue prints in the Museum's model shops. Scale 1 to 24.

its final manufacture. Tapping methods will be illustrated by means of actual tree sections and tools while the processes of coagulation and vulcanization will be demonstrated in experiments performed by the guide.

The fabrication of other products mentioned above will be similarly treated. After a historical introduction the manufacturing processes and the uses of each individual class of products will be explained by means of tools, specimens, motion pictures, transparencies, and other educational aids.

One twenty-foot alcove has been assigned to a demonstration of the principles of wood finishing. Here the visitor will be able to study the structure of the most important commercial woods and see them polished, stained, and finished in many different ways. In another alcove will be reconstructed a wooden shoe shop which formerly stood in the little town of Parnot, Haute-Marne, in France, the entire contents of which the Museum obtained recently. Similarly, a wood-carver's shop will be installed, complete with tools and finished work.

The manufacturing processes surrounding the pulp and paper industry, naval stores, and wood preservation will be displayed in the halls immediately following the special forest products exhibits. In the preparation of the displays depicting these activities the curator of industrial chemistry section and the forester are working in close coöperation, a practice which insures the presentation of a picture in which both forest and laboratory will receive equal emphasis.

Logically interspersed throughout the forestry section will be charts, maps, diagrams, and pictures indicating the social effects of the numerous and varied developments and processes. In the preparation of this data an effort is being made to present the statistical matter in a lively, colorful, and impressive manner.

BRIEFER ARTICLES AND NOTES

Litter Deposition and Accumulation in the Pine-Oak Type of the Southern Appalachians

Field observations and experiments now in progress at the Bent Creek branch of the Appalachian Forest Experiment Station indicate that wide differences exist in the rate at which forest litter decomposes and in the amounts of litter present in the different hardwood types of the Appalachian region. In any particular stand the accumulation of litter is, of course, dependent on the rate of decomposition as well as on the age, density and composition of the stand. In the best coves leaf litter practically disappears in one year after it is deposited. The other extreme is found in stands of pitch pine in which four years or more may be required for complete decomposition.

Litter relations in the Bent Creek experimental forest are now being studied by means of a series of permanent sample plots which have been established in a representative lower south slope pine-oak mixture. One plot was burned over, another was raked clean of litter, and two others were left as checks. The stand in which the plots are located is uneven-aged and has a crown density of about 0.9. The area has been undisturbed for at least 10 years previous to treatment.

All litter determinations have been made by taking 6 random milacre samples per plot. Moisture content on oven-dry basis was computed from two 30-gram samples taken from each milacre. The data are presented below in pounds of litter per acre, oven dry.

On the plot designated for burning, 6 samples taken before treatment indicated that the accumulated litter amounted to 7,900 pounds per acre. The standard deviation of the 6 samples was 1,500 pounds. On the plot to be raked the indicated leaf litter layer amounted to 6,300 pounds per acre (standard deviation of 6 samples 800 pounds). Similar determinations of the leaf fall the first year after treatment showed 3,100 pounds (standard deviation 400 pounds) deposited on the burned plot and 2,600 pounds (standard deviation 300 pounds) on the raked plot. On the basis of these observations it would appear that the normal accumulation of litter in all stages of decomposition weighs two or three times as much as that deposited in one year. Inasmuch as the decomposition is progressive and probably begins the first summer after deposition, it is certain that more than 3 years are required for the complete disappearance of any one year's litter.

It is entirely possible that the above figures for annual leaf fall are below normal for the type, due to the drought conditions that prevailed during the year 1930. A deficiency of 15 inches from a normal of 40 inches precipitation was recorded at Asheville, North Carolina, which is 10 miles from the plots. The soil on both plots dried out considerably during the summer so that it is doubtful if sufficient water was available for the trees to produce full crowns. Then, too, the fire caused considerable damage to the crowns of the hardwoods on the burned plot and killed a number of the smaller trees. Lowered

tter production, due to these causes, as offset, however, by sprouting of ardwoods and premature shedding of eedles from injured pine crowns.

Investigations elsewhere have shown aat the beneficial effects of forests on an-off and erosion are due to the presnce of litter on the forest floor, and that ae removal of the litter by fire results in reatly accelerated erosion. The plots at ent Creek have shown that the light liter deposited the first year after a fire is ot sufficient to prevent frost heaving, hich is a very important factor in the rosion of exposed clay soils over a large art of the Appalachian region, and that takes at least 3 years to replace the tter removed by a fire. Thus the soil exposed to serious erosion for at least ne year and possibly for 3 years after fire.

Fertility of forest soil is closely conected with microbiological activity in ae litter. Partial or complete sterilizaon of the litter, together with the charing of unconsumed material and the rying which follows exposure, constitute very serious interference with the noral biological activity. Just how many ears are required for the environment to ecome again suitable for the normal, omplex balance of organisms is one of ae questions that the plots are expected answer, but the answer will not be orthcoming for some years. This period ertainly cannot be less than that reuired to restore the normal accumulaon of litter and may conceivably be auch longer. It is to be expected that ais hiatus in the biological activity will e reflected in the growth of the stand.

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Type Successions in the Olympic Mountains

In general as our work has taken us into the forest areas of the western Cascades and the Olympic Mountains we have noted in a more or less detached manner that western hemlock appears to replace Douglas fir on areas where neither fire, wind-throw, nor cutting operations have taken place for a long period of time. This has created a rather general impression that Douglas fir is a temporary forest type, dependent for its preservation on some form of accident or cutting operation in order sufficiently to open up the stand for a new crop to supersede the old one. At the same time the impression has also prevailed, barring such accidents as fire and wind-throw or cutting operations, that western hemlock will replace the Douglas fir and remain a climax or permanent type as long as the stand is kept in a closed canopy form.

Truly, we do get hemlock as an understory in our overmature Douglas fir forests, and hemlock does replace the fir in time, barring fire or other causes; but is hemlock the climax or final type over most of the area west of the Cascades or in the Olympic Mountains?

This past season I had very good opportunities to check on the interesting problems with type succession in the southwestern portion of the Olympic National Forest, principally in the two Humptulips drainages and the Satsop River areas. In these watersheds are seen some of the best illustrations of considerable-sized areas that have escaped fires or windthrow for hundreds of years—how long no one knows. This condition has resulted in various steps in the gradation from the pure Douglas fir type to the so-called ultimate or climax type, which in this region appears to be silver fir (*Abies amabilis*) without question.

Picturing the various steps in this transition we have the following:

1. A fire or wind storm wrecks the growth and through some means a Douglas fir forest follows. This forest type retains a comparatively dense crown canopy for a considerable period, thereby preventing a reëstablishment of a similar stand under itself because of its inability to regenerate under shade conditions. Meanwhile, with advancing age, as the crown canopy opens up slightly, western hemlock becomes established as an understory type, forming usually a rather low grade forest of slow growth with short and limby boles, highly subject to fungus attack. Usually by the time the Douglas fir has reached an age of from about 300 to 350 years the hemlock is the dominant understory type with trees of all ages and sizes up to three or four feet in diameter and from 200 to 250 years maximum age. At this time the Douglas fir has gone somewhat beyond its peak and as a forest is on the decline; although as an individual tree it is probably just arriving at the period that it commences to acquire its greatest value from the quality production standpoint and is also approaching that period of its life that it attains its most striking appearance.

2. At about this period or shortly thereafter we notice the entrance of silver fir in the underwood, coming in as an understory type to both the hemlock and Douglas fir. The latter type is becoming more and more open in its crown density, the hemlock crowns are gradually filling in the space formerly occupied by the Douglas fir, and we have now essentially a forest composed of two species instead of one; the even-aged Douglas firs still dominant with their crowns extending from 250 feet to 300 feet into the air, and the hemlock as a codominant and suppressed species, various-aged, the oldest trees some 100 or 150 years younger than the Douglas fir. The third type (silver fir) is just getting started in the understory beneath the western hemlock.

3. Another stage is reached in the future when, due to fungus attacks, windthrow, etc., the Douglas firs are rather widely scattered, of large diameter (5 feet to 8 feet) and form only a comparatively small number of trees as compared to the aggregate, although still making up a considerable proportion of the merchantable volume, perhaps as high as 55 per cent. At this time the Douglas firs are probably between 500 and 600 years of age. The hemlock is also pretty well advanced in age and is well on the decline, this species being much shorter lived than Douglas fir, many having already succumbed to disease or windthrow. The understory however is still too dense for Douglas fir seedlings establishment, and so with the gradual dying out of the hemlock and Douglas fir, silver fir takes the opportunity to make its bid for supremacy in the forest and commences to fill in the spaces opened up by its two predecessors.

(At this point it may be well to bring out that silver fir is one of the most remarkable trees to respond in both height and diameter growth when opened up to light and freed of root competition. Trees growing suppressed for from 70 to 100 years and only from 2 to 3 inches in diameter and 10 or 15 feet tall, show an exceedingly good pick-up, and after a few years have the appearance of young trees above the height they had at the time of liberation.)

The last stage is presented with the decline of both Douglas fir and western hemlock to the extent that these two species occupy only a very small proportion of the crown canopy or are entirely lacking, and the dominance of silver fir over the area that was once a Douglas fir type. Such areas are very much in evidence on the western and southern slopes of the Olympic Mountains in Washington, and are characteristic over considerable areas

here. Evidence of the former Douglas fir nd western hemlock trees are on the round and as standing snags in various tages of decay; and in all such cases he evidence of fire or wind-throw is acking as to their occurrence within a eriod of perhaps 500 years or possibly ven longer. One can travel days in the orests there and find no charred stumps, o charcoal, nor anything indicating a urn except occasionally in recent years lightning-struck tree which flared up or a brief period and may have burned ver an area from a few sticks to perhaps 10 to 15 feet across. Rainfall is eavy, from about 75 inches to 140 nches annually, fogs and mist are common in the spring and fall months and he dry season is comparatively short, sually from about the early part of July the middle of September.

The final stage of this forest area appears to be an uneven-aged stand of silver r, which will probably reign supreme ntil some form of catastrophe comes long and opens up the stand; then it ill be possible again for other species obtain a temporary foothold providing he necessary seed is available; otherwise lver fir will take hold in the openings nd again establish itself to the exclusion f other species.

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A Note on Jeffrey and Western Yellow Pine

It is a well known fact that Jeffrey ine (*Pinus jeffreyi*) and western yellow ine (*P. ponderosa*), although closely reated botanically, differ considerably as ar as their biochemical characters are oncerned. Oleoresin of the former conains an aliphatic hydrocarbon, heptane, nd a small amount of certain aldehydes, all these constitutents being of normal structure. Oleoresin of the latter species contains hydrocarbons of a different nature, namely terpenes with an admixture of a sesquiterpene.

The writer has been experimenting with both species for several years in Lassen National Forest, California, and among his experimental trees has found some of exceptional interest from a biochemical point of view. In the present note attention is called to two particular specimens.

The first one is yellow pine that exhibits certain of the morphological characters of Jeffrey pine. Distillation of its oleoresin, preformed at the Forest Products Laboratory at Madison, Wisconsin, revealed the fact that the volatile oil obtained has a distillation range intermediate between that of Jeffrey pine and western yellow pine. It was concluded that this volatile oil is composed of a mixture of heptane and terpenes. Probably due to the small amount of the material, no attempts were made to identify terpenes or to find out whether or not an aldehyde fraction so characteristic to Jeffrey pine oleoresin is present. More complete analysis of this mixed oleoresin is certainly desirable.

The second tree, apparently the result of the merging of two trees, is of even greater interest. Originally there were probably two trees, one a western yellow pine and the other a Jeffrey pine, growing very close to each other; in the course of time the two trees came to intimate contact. At present, from a forester's point of view, these two united trees might be considered as a single individual since it forks above the breast height point. From a biological standpoint also the two grow as a single organism. The most recent annual rings in the sapwood encircle the two trees as one unit. In other words, the cambium, once continuous for each tree, now, since the

union, encircles both without interruption. The outer bark, although uninterrupted, exhibits on each respective side characters peculiar to the original species. When a horizontal scar was made with a turpentine tool at the point of union between the two original trees, oleoresin flowed from all parts of the wound, but its left, or yellow pine half, produced turpentine—containing oleoresin while the right or Jeffrey pine half yielded heptane oleoresin. The dividing line, otherwise unmarked, could be easily detected, as turpentine oleoresin flows from a wound in a manner distinctly different from that of heptane oleoresin. The former is oily and smears readily over the wound, while the latter appears in the form of minute brilliant globules that retain their shape for a relatively long time.

Oleoresin from the yellow pine side of the tree has not been examined, but the Jeffrey pine side has been tapped for heptane for three seasons and has yielded products of the same quality as any typical specimen of Jeffrey pine. An anatomical study of this tree and chemical analysis of its oleoresins might reveal many interesting facts relating to the biological relationship between the two species. It should be recalled that some botanists cannot accept Jeffrey pine as a separate species and regard it as a variety of *P. ponderosa*.

This twin tree, known as No. 231W, as well as the above-mentioned supposed hybrid (No. 231X) and two other nearby typical Jeffrey and yellow pines of interest for comparison were appropriately tagged. Since the whole area on which these trees are located is to be logged in the near future, an understanding has been reached with local Forest Service authorities in regard to preserving these specimens for future experimental pur-poses or reference.

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Releasing Merchantable-Sized Spruc[e] and Fir Through Girdling

Additional data obtained from girdlin[g] experiments indicate that highest return[s] in dollars can be realized through gird-ling hardwoods which are suppressin[g] pulpwood species already of merchant-able size. This is obvious since the bul[k] of the increased growth resulting fro[m] reduced hardwood competition will b[e] added to merchantable crop trees hav-ing marketable value.

Definite figures on increased growth o[f] merchantable crop trees following gird-ling of hardwoods were obtained from [a] girdling experiment located in a typica[l] mixed spruce and northern hardwood[s] stand on the holdings of the Easter[n] Manufacturing Company lands near Pa[t]-ten, Maine. Girdling of all hardwood[s] on the plot down to 2 inches d.b.h. i[n] 1919 released 40 spruce and fir per acr[e] with an average diameter of 8 inches an[d] a volume of 272 cubic feet (2.8 cords). Eleven years later, instead of a yield o[f] 412 cubic feet (4.3 cords) which it i[s] calculated would have occurred in th[e] absence of girdling, the plot showe[d] 1050.4 cubic feet per acre (11.0 cords) of merchantable pulpwood, an increas[e] directly attributed to girdling of 638.[…] cubic feet (6.7 cords). Even during th[e] first 4 years following girdling the in-crease over normal growth amounted t[o] 115.2 cubic feet (1.2 cords). The num-ber of merchantable trees during this pe-riod had increased to 160.

Periodic annual growth rose from on[e-]seventh cord per acre per year to thre[e]

ıarters of a cord which is a 5-fold in-ease in the growth rate. It is calculated at the increased growth resulting from rdling during the eleven year period tted a profit of $2.00 per acre per ar.

The experiment shows that profits on rdling investments in stands containing op trees of merchantable size can be alized in the relatively short period 4 years. Moreover it appears that in ch stands the added growth put on the st 2 years following girdling will more an pay for the girdling costs. Should e or other damage make it necessary salvage the crop within a few years ter girdling, it would be possible to do without loss of the initial girdling vestment.

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In Tech. Note No. 8, Northeastern Forest Experiment Station.

Pure Versus Mixed Plantations

In view of the enlarged forest plant-g programs in several regions the fol-wing statement, by Professor R. T. sher, Director, Harvard Forest, com-ring pure and mixed plantations, is timely interest. The statement appears a foreword to a bulletin by A. C. Cline, ssistant Director, Harvard Forest, and J. MacAloney, Assistant Entomologist, S. Bureau of Entomology, and en-led "A Method of Reclaiming Severely eeviled White Pine Plantations." It is ailable as Bulletin 152 from the Massa-usetts Forestry Association, Boston, ass., at 25 cents per copy.

The bulletin itself gives a clear descrip-n of how severely weeviled plantations ay be rescued from further degrada-n and changed from a prospectively lueless stand to one of real worth. The atment is described by text and illus-tion, and consists of selecting the least injured trees and favoring or freeing them for use as final crop trees. Stands above or under profitable pruning size are considered. The effect of the treat-ment on fire hazard, insects, and fungi is also discussed, and cost and returns data are offered.

Professor Fisher's statement follows:

"The experience of the last twenty years has shown that the former high value and productiveness of the white pine woodlot were no indication that pure planations of the same species would be equally profitable. The factors which made the natural crop a success have not been repeated with the artificial or planted forests. Even without the decline in use and marketability which old field pine has recently suffered, the reasons against growing it would still be con-clusive. Pure pine stands bring about a deterioration of soil, which is reflected in early falling off of growth. They are highly susceptible to disease and injury. Natural pruning is slow, and even under the best conditions—expertness in plant-ing and sufficient density—no high grade lumber is produced. Most serious of all, such plantations have greatly contributed to the present prevalence of the white pine weevil. In many parts of New Eng-land the destructiveness of this insect is now so great that without some corrective treatment the great majority of planta-tions will have lost what little prospec-tive value they had in the beginning.

"As a matter of general forest policy the way out is to turn to natural mix-tures, widely available already in the young growth on cut-over lands, to grow white pine sparingly and always with other species, preferably hardwoods, a procedure which has been shown in many cases to be cheaper, always better for the soil, and conducive to a higher grade of timber and comparative freedom from weevil damage. For thousands of acres of existing planations there is no hope

of ultimate return unless a way can be found to improve the quality in at least a portion of the mature stand."

Strength Tests of European Douglas Fir[1]

Of all the exotic species which are planted in Germany at the present time, Douglas fir is the most popular not only because of the rapidity of its growth and the excellence of its wood, but also because of the quality of the humus conditions which prevail in its stands and its freedom from disease. Since this species is planted so extensively in Europe, the quality of the wood which it produces very properly becomes a subject for rather critical research, and in consequence a study was undertaken (1) to compare the strength of the wood of the fast-grown European Douglas fir with that of slow-grown American specimens, (2) to compare the strength of second-growth timber with that of virgin growth (United States), and (3) to determine the degree of correlation between ring width and strength in European grown wood. Several wood technologists have investigated the quality of the wood from rapidly grown European trees, but they selected too few and too young specimens to obtain uniform results.

The data for the investigation were obtained from tests, viz: static bending; compression parallel to the grain; hardness; and shear parallel to the grain. In every case the methods approved by the American Society of Testing Materials were used in order that the results obtained might be compared with those already published for this species by the forest products laboratories of Canada and the United States. The specimen came from several parts of German and Denmark, and the virgin materi and some second growth timber were se from the Pacific Coast and from th Rocky Mountain region of the Unit States. When possible the specimens we tested in the green condition, but in som instances this was out of the question air-dried material was used. Howeve for specimens below the fibre-saturati point comparisons were made only those cases where the moisture conten were equal.

The European specimens tested in t green condition showed the results very rapid growth, and some (especial from the lower portions of trees) exhib ited compression wood. These gre specimens were equal to the Americ Douglas fir only in their resistance rupture; their resistance to compressi parallel to the grain and their modu of elasticity in compression and sta bending were lower than is typical of t American grown timber. On the contra the air dried specimens which were slower growth were equal to the Ame can material except in the case of elasti ity in compression which presented lower value. In respect to hardness, t fast-grown European wood showed greater degree of resistance than the sp imens from the western United States, feature which agreed with results o tained for English-grown Douglas fir the Forest Products Laboratory at Prin Risborough in England. From the sults obtained by these tests it would a pear that the strength of young (4 year-old) rapidly-grown European Dou las fir argues well for the prediction th timber from higher age classes will p sess the same high qualities which featu

[1] Abstract of "Festigkeitsuntersuchungen an Douglasienholz; Mitteilungen aus Forstwirtschaft u Forstwissenschaft, s. 132-208, 1931."

e wood from trees growing within the ıtural range of the species.

The tests of second-growth timbers ere too few to justify generalizations, ıt those which were made seem to indi- te that young rapidly growing and old ees produce wood which is light in eight and weak in its resistance to ap- ied forces. On the other hand a medi- n growth rate is favorable to a maxi- um production of summerwood with concomitant increase in strength ir- spective of the country in which the ees grow.

It has been shown that the specific avity and strength values for Douglas increase with an increasing ring width to an optimum of 2.5-3 mm for the ıropean and of 1.5-2 mm for the virgin- own (American) wood, and that any rther increase in the depth of the ring accompanied by a decrease in density d strength. This rise and fall in qual- has its origin in the volume of sum- erwood which approaches a minimum comparison with the amount of spring- od as the width of the ring departs either direction from the optimal value st mentioned. This tendency is still rther accentuated by the fact that this ninution of the per cent of summer- od is accompanied by a decrease in thickness of the tracheid walls and an crease in the diameter of the lumina. other words, the loss of density and ength as the ring width departs from 2-3 mm value is due not only to a ative decrease in the number of sum- rwood cells present but also to an ac- ıl decrease in the volume of solid sub- nce of which the walls of these sum- r wood cells consist (thinner walls and ger lumina). In some cases, however, id growth is accompanied by a pro- rtional increase in the volume of the mmerwood, but even in these cases the ısity and strength are low.

This peculiar divergence from an optimum ring width may explain why some authors maintain that the strength of Douglas fir wood increases directly with ring width while others maintain that the reverse is true.

The influence of the "growth region" on the strength of the wood of Douglas fir can be learned from strength values obtained at the American, Canadian and English laboratories, which show that favorable growth conditions (climate, soil, etc.) can be correlated with high specific gravity, as well as the absolute and relative strength values of the wood. On the contrary, even though the European Spruce produces a large volume of wood under optimum growing conditions, that wood may be of very poor quality in respect to strength.

Tests showed that the compression wood found in certain specimens had a lower volumetric shrinkage value than was characteristic of normal specimens but agreed with the latter in specific gravity and strength with the exception of elasticity, in which property it was much lower. High longitudinal shrinkage is typical of wood of this type, and for this reason in addition to its low elasticity, compression wood should not be used as a building material.

Since the German grown Douglas fir is not utilized for pulp but for general construction, it is essential that the wood should possess two qualities, namely: strength and durability, and to insure these it would appear to be worthwhile to so plan the silvicultural practice that the timber will be free from knots and of high density. Up to the present the trees have been well separated in the plantation which system fostered rapid wood development and a correspondingly low specific gravity and a great number of large knots. From the results of these studies it would appear that the spacing of the trees might be reduced to advantage in order to achieve a better balance

between quantity and quality production.

It might be advisable to reduce the planting distance to 1.00 or 1.25 meters as is now being used for most species in Germany. In this way the rate of growth of the young trees would be retarded, and the lower branches would have a greater tendency to die. Since these dead branches do not fall off, it would be necessary to resort to artifical pruning (of the dead branches only) in order to obtain clear lumber.

As the stand increases in age, regular thinnings would be necessary in order to defer the slowing up of diameter growth (a decrease of ring width below the 2.5 to 3 mm optimum) as long as possible, since in this way, even in the higher aged stands, a proper balance between quantity and quality production could be maintained. The cost of pruning and the small loss in volume involved in such a system would be offset by the higher prices which could be obtained for the clear, strong lumber.

Some such system will be even more necessary when Germany develops a rigid code of grading rules such as now obtain in the American lumber industry. A tendency toward more rigid grading is already evinced since engineers are increasingly insistent in their demands for specific information regarding the quality of timber which they are using.

A comparison of Douglas fir grown in Germany with that of indigenous German conifers shows the following:

1. The optimum ring width is greater than that of larch (*Larix europaea*), Scotch pine (*Pinus sylvestris*), or spruce (*Picea excelsa*).

2. The specific gravity and the absolute strength values for the wood exceed those for spruce, are less than those for larch, but equal those for Scotch pine. In contrast, the relative strength values (strength conforming to a single specific gravity), are less than those for spruce, but greater than those for larch.

3. On a given area and under favorable conditions, Douglas fir produces more wood substance in a given time than typical of any conifer in Germany, since it exceeds the spruce in growth and produces wood of a higher specific gravity.

4. The American "safe loads" for Douglas fir are equal to those for larch in Germany.

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REVIEWS

Edited by Dr. Henry Schmitz, University of Minnesota, St. Paul, Minn.

orest Management. By Herman H. Chapman. *J. B. Lyon Company, Albany, N. Y. $4.50. Pp. 544.*

In *Arctic Rodeo,* David Streetor records ıe longest journey ever taken as that of ucatelli who said "Farewell, good sirs, am leaving for the future. I will wait or Humanity at the crossroads three undred years hence." Not upon such a ourney do we depart with Prof. Chapıan yet that forester is fortunate who ects the happy highways of Forest Mangement under his direction. Upon peaks f clear vision, through narrow valleys of one-way-routes" and past dense jungles f doubtful passage the traveler is led, ith many questions, some fears for the ıccessful completion of the journey, yet ways with a poise, a precision and a atience which give calm assurance that ıe guide has traveled the route before.

Since the beginning of time mankind as been faced with the choice either of ıe mastery of the mind or the mastery f the hand. When the Serbian peasant lavius Anicius Justinianus (527 A. D.) ecame ruler of the Eastern Roman Emre he boasted of his ignorance and the literate farm hand, all powerful and hooled in the mastery of the hand, sucssfully obliterated the one remaining hool of those trained in the art of eroglyphics. Centuries of generations mankind strove to undo the task "His ajesty" so well completed and at treendous cost finally succeeded. Within e year 1931 a young English surgeon, ot yet thirty years of age, a disciple of e mastery of the mind, to the end that he may be master of his handiwork, gives to the world a new hope in the control of the scourge of cancer.

Yes, the comparison of the illustration is almost if not altogether absurd, and there would be no justification for the mention made were our profession not faced with a situation which brings such an illustration to mind.

There are those who speak lightly of the value of an extensive and complete forestry library (Flavius had no use for "book-learnin' ") readily available to the students. There are those who cry from the hill tops for practical training of foresters and have little time for the idea of an intensive cultural training for the foresters of the future. On the opposite side are those who would make the cultural and educational requirements of the forester the equal of the standards of any profession in the land.

When an author brings to the councils of a group of such varied opinions a new book he must expect criticisms, disagreements and even utter disregard. Happily the lot of the reviewer is to open the book to those who would peruse its pages.

The philosopher Heine said "Every age has its problems, by solving which humanity is helped forward." The problem of the next fifty years in the view of Otis Moore is to combine, with the minimum of loss, "the virtues of the Russian Soviet, the virtues of the fascist discipline and the virtues of private initiative." Whether Moore is right or not, there is general agreement that our economic situation overshadows almost all other

serious problems. Prof. Chapman has given recognition to this and has drawn his sketches of conditions and principles upon the background of economics. Quite naturally he has looked into the future and has even dared to dogmatize, yet with so much justification that he must receive substantial approval of his forecast.

Preparation for the main thesis of the book is made under two well chosen headings of The Place of Forest Management in Forestry (Part I) and Forest Organization (Part II). It will be somewhat difficult for all to agree entirely with what is said in Part I. However even those who demand the contracting of all government timber to a limited few, well-organized companies in clearly defined working circles as the solution of our present lumber difficulties will find the author well within safe bounds when he says, (page 52), "the proper regulation of this operation (the cost of logging) so as to secure the best possible conditions for reproduction and growth is the most important part of the business of forestry." Neither should there be much divergence of opinion from his definition of the practice of forestry by a timber land owner (p. 63) although the lists of owners practicing forestry on their properties would not check one hundred per cent with his standards.

Probably in no other book on forestry can the student find so concise and clear a statement of the principles of economics as related to forestry, as is found in Chapter 6. The author has given the body of forestry students, and the profession, an up-to-date analysis of the foundations.

The principle of profit and the principle of maximum production might well prove, in their discussion, to be controversial subjects. But Prof. Chapman has chosen to remain upon a broad foundation, wholly defensible, where there is much latitude. Another quarter of a century may witness these principles the center of a bitter controversy and debate. In fact there are signs pointing quite definitely that way at present, *e.g.*, the sage of the *Emporia Gazette* urges that "Only upon the balance between the rights and duties of the dollar can our present order survive." President Glenn Frank is quite emphatic that "to say we are now or shall be for generations to come at a point where humanity is surfeited with goods and services it does not need for better living is to my mind too incredulous to consider seriously."

Too much praise, it seems, can not be given for the careful manner in which the author has prepared a wide variety of diagrams and figures in explanation of the text. They abound throughout the book, yet the reviewer's attention was particularly attracted to those in Chapters 9, 10, 11, 15, 28, and 29, *e. g.*, pages 127, 184. The instructor who may be in some difficulty due to faulty or insufficient data for class use can find the foundation, in these diagrams, for wealth of illustration from his own field experience. Chapter 16 likewise will be welcomed by instructors as going farther than anything hitherto available to clear up the confusion of terms and reasons for each term used in designating subdivisions of the forest area.

It is in Chapter 20 that the author sets the pace which has given his work a distinction surely to mark it as a standard. Through discussion, illustration, explanation, the student is brought definitely in paragraph 193 to see the relation between two terms often misunderstood, the working group and the working circle.

Continuing into a still more confusing terminology the author has given meticulous care to the sentences under rotation, cutting cycle and normal forest with the result of a clarity greatly to be desired.

Probably no more sane and scientif

discussion of the possibilities inherent in regulation is in print. Here the professional forester, the lumberman-owner, and the technician each may find much to justify the reading. The introduction of the term "Regulated Empirical Growing Stock" as descriptive of a condition distinct from that of the normal growing stock will be welcomed by all teachers who have labored to clarify the confusion which so often arises in the student mind.

The esteem in which the methods of regulation are held in the United States, covers the whole range of practitioners and theorists. The gestures made in their use are hardly less frequent than the loud (?) claims of their futility. Their validity is called in question. It needs only to be clearly and convincingly shown that they are of real value, are practical and thoroughly understandable. All this the author has done in a most acceptable style.

In the discussion of the horizontal cut as a method of regulation Prof. Chapman has expanded, clarified and illustrated this, his own contribution to the methods of regulation, in a most complete and unique manner. The chapter on the regulation of wild forests presents a practical problem to all acquainted with conditions in the Western United States and leaves nothing to be desired in an understanding of the problem involved.

Finally fifty pages of very practical material on management plans and the control of operations under the plan make of that portion of the text book a hand book of practice for foresters charged with the actual operation and management of a forest property.

The publishers are to be congratulated upon a craftsmanship of a high order evident to one who but fingers the pages.

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Waldbau. (Silviculture.) Lectures by Julius Oelkers, Professor at the Forest Academy Hannover—Muenden. *Hannover, M. & H. Schaper, 1930-31. Part I, pp. 1-120. 1930. Part II, pp. 121-263. 1931. Other parts to follow.*

In effect this is a syllabus of silviculture based upon Prof. Oelker's lectures at the Prussian School near Hannover. The first part deals with stand factors; the second part with the silvicultural characteristics of individual species.

The book is largely a compendium of data in succinct form. Its use as a reference work is enhanced by the inclusion of data on important species in all parts of the civilized world—not only in Europe.

Thus we find our North American species of consequence listed—with synopses of salient botanical and silvical features. In the case of spruce, a curious omission occurs—after mentioning Engelmann, blue, Sitka, Brewer's, white and black (which he calls "nigra") spruce, one looks in vain for the most important of them all—*Picea rubra*—the red spruce of our northeastern forest. This, however, is the only serious omission in an otherwise excellent reference work.

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Ueber Bodenazidität im Walde. (Acidity of Forest Soils.) By Dr. Eugen Frank. *Freiburg. 1927. 155 pages.*

The author analysed nearly 2,500 soil samples obtained chiefly from the forests of southern Germany (Schwarzwald). Besides the hydrogen ion concentration, the total and actual acidity was determined by titration. Acidity was studied in relation to humus, texture and moisture of soil, geological substratum, aspect, character of forest stand and composition of ground cover. Special atten-

tion was given to both the horizontal and vertical variation of acidity in forest soils. The possibility of changes in the reaction during different seasons of the year has also been taken into consideration.

The most important results of the analysis are the following:

1. The concentration of hydrogen ions of forest soils investigated fluctuates from pH 3.0 to pH 8.0; total acidity by titration varied from 1.3 cc normal HCl to 180 cc normal NaOH, and the actual acidity varied from 0.3 to 12.7 cc.

2. Acidity of the upper layer (0 to 8 inches) depends mainly on the composition of forest stand and the density. With the greater depth the acidity of soil decreases (with the exception of podsolic soils with hardpan layer).

3. The soils with raw humus have the highest acidity. Loamy and clayey soils are more buffered than sandy soils and for this reason they even with relatively lower concentration of hydrogen ions may show a higher degree of total acidity, determined by titration. The most acid soil substrata are those which have originated from granit and gneiss rocks.

4. The higher elevations (over 2,500 feet above sea level) have on the average higher acidity than the lower elevations. The ridges, tops of hills and higher plains are more acid than the adjoining lower localities. The northern exposures are the most acid.

5. Under the same soil and geological conditions the soils of coniferous forests are more acid than the soils of hardwood and larch stands. Therefore, the planting of hardwoods and larch instead of pine, spruce or fir species materially decreases the soil acidity. Opening of the stand results in decrease in acidity; for this reason before underplanting older stands on the acid soil, the soil acidity should be reduced by partial cuttings.

6. The plants which were found to be associated with the most acid soils were blueberry, heather and many of the mosses. Fescue grass, meadow grass, melic grass and wood rush occurred on soils of lower acidity.

7. Local climate has an influence on soil reaction. The acidity changes with the seasons of the year. Running waters moderate the acidity; stagnant waters produce higher acidity.

8. High acidity, as well as alkalinity of soil are unfavorable for the germination of seeds and for the growth of trees. Scotch pine tends to occur on the most acid soils, while the ash tends to occur on the less acid soils. Norway spruce, European fir, oak, beech and larch in their proper order occupy the intermediate position.

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Flood Control on Alluvial Rivers, I By Fred H. Tibbetts. *Engineering News Record, Vol. 107, No. 14. October 1, 1931. Pp. 520-524.*

The control of floods becomes more and more important from different points of view as population and development increase. Urban improvements and intensity of cultivation of farming lands near rivers call for improved and refined methods to eliminate the waste caused by floods in resources, interruptions of orderly business, and in community morale. The author has ably presented these aspects of flood control and has emphasized the need of "broader vision and understanding" on the part of the engineer adequately to plan and design for the control of floods.

By implication it is assumed by the author that the engineer, alone is charged with the task of protecting man and his works from the damages and destructio

f floods. Furthermore, the author states hat the "works of man tend to increase he frequency and height of floods" where ultivation in lowlands and deforestation n uplands are included. "In the long un this work of man is of the greatest nportance," the author continues, suggesting that such flood damages in China uring recent centuries as well as the ater stages of the Sacramento River durng the past 50 years are responsible to uch works. While these works of man ithin watersheds are recognized, the uthor omits consideration for improveents in these matters as part of flood ontrol programs.

In this respect the reviewer calls atntion to a deficiency in this otherwise ble and authoritative paper on flood ontrol. The reference to "reforestation" xpresses an academic view by a praccal engineer. Reforestation implies the lanting up of lands to trees. In reality e soil mantle of a watershed is the ajor storage basin. Without the great etentive capacity of the weathered rock nd overlying mass of porous soil, a oderate rain would overwhelm valleys ith torrential flows of run-off coeffients approaching 100 per cent of the ainfall. Alluvial valleys would cease to e habitable. It is so often erroneously nplied or stated that forests by their etention and absorption control flood ows. Since the retention capacity of a rest canopy and its layer of ground tter actually is not great, scarcely ever qualing 1.0 inch in depth of rainfall, it implied that in the extreme flood stages rests have no effect. This conclusion so enerally found in engineering textbooks an instance of purely academic inducve reasoning. No adequate evidence has er been brought to bear upon this queson. It is only necessary to contemplate hat the flood stages of the Sacramento Mississippi rivers would be should eir respective watersheds be entirely bare of any vegetation under the same storms, to see the absurdity in the statement that forests have no effect in extensive flood stages.

When it becomes more generally known just how a mantle of forest or other vegetation functions in facilitating the infiltration of rain into the enormous storage mass of the soil, and how vegetation influences the accumulation of surficial run-off, such statements by the author will be fundamentally changed. Likewise the idea of "reforestation" will be radically altered. A series of experimentations within the past six years has indicated that a more exact concept of the influence of a mantle of vegetation, whether it be grass or forest, is that the maximum infiltration and storage capacity of the enormous mass of soil covering watersheds is made possible by the presence of a natural and complete mantle of vegetation, and by the soil fauna which derives its food supply from the vegetation, living and dead. Maximum streamflow control, accordingly, resides in maintaining the soil mass at its greatest absorptive capacity. At the same time the maintenance of the rate of erosion at the inevitable geologic norm, which represents generally the highest attainable control within practicable limits, is made possible by the natural mantle of vegetation.

The baring of soil by cultivation exhibits one of the important means of increasing run-off. Fortunately, cultivation is usually confined to lands of gentle gradient and of lower precipitation than obtains in mountainous areas. Yet much improvement is desirable in the methods of cultivation, and these fall properly within a consideration of flood control. In the same way any other treatment of lands, as by grazing or lumbering or fires, which bares it and removes the influence for maximum infiltration and storage of waters can not properly be

omitted from a consideration of the control of floods.

Erosion accelerated above the geologic norm is generally inadequately measured by silt determinations. It is the ponderous bed load which is set in motion and moved only short distances each year that will confound in time the accurately designed flood control works along stream channels. It is certain that by the omission of improvements on the watershed surface work for engineers occupied with channel control will be greatly augmented at public expense. Such motives might be imputed if it were not for the high integrity and sense of public service which characterizes the profession of engineering.

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Assessment Ratios of Forest Property and Other Real Estate in Wisconsin. By R. C. Hall. *Progress Report No. 12 of the Forest Taxation Inquiry. 1930. Pp. 13, plus 2 exhibits, 19 tables and 3 figures.*

This monograph fully maintains the traditions of painstaking investigation and scholarly analysis that have been established by the Forest Taxation Inquiry in preceding reports. The study is based upon data covering 11,327 parcels of property, obtained from the real estate transfer records of the Wisconsin Tax Commission, and supplemented at some points by independent field investigations. Geographically, it involves nineteen Wisconsin counties—the seventeen northern forest counties, and two counties used as samples of conditions in other sections of the state. Approximately one-third of the report is devoted to explanation and analysis; the balance consists of detailed statistical exhibits and related ancillary material.

It is shown conclusively that cut-over properties are grossly over-assessed in comparison both with other types of rural property, and with village and city property. The assessment of cut-over land, furthermore, is characterized by extreme variability. Timber properties, on the other hand, have a lower average assessment ratio than does any other class of properties, and are assessed with a relatively high degree of uniformity. Resort and rural residential and business properties are so assessed as to be more favored than farm land, but less so than timber. Several possible explanations for this disparity in the treatment of the several classes of property on the part of assessors are suggested and discussed.

By combining the facts brought out in this report with those disclosed by other investigations, it is apparent that in the northern Wisconsin counties rural property (with the exception of cut-over land) is under-assessed in comparison with urban property, whereas in the southern half of the state this relationship is reversed. It may be noted that the probable explanations of this situation are two: first, that assessments throughout the northern part of the state are poorer and less equitable than in the southern part, and poor assessments tend to be low assessments; and second, that urban property values in northern counties have been declining, while those of southern counties have been steadily increasing.

In view of the variations in the assessment levels of property classes, the question arises—what is the effect of Wisconsin's unique system of equalization upon the misplacement of taxes as among these property classes? The conclusion reached in this report is that "though the Wisconsin equalization system may be effective in making a reasonable distribution of taxes between taxing districts, it does not reduce misplacement of state and county taxes between property classes b

s inclined to increase such misplace- ient" (p. 10). Even if this conclusion e accepted in full (and it rests upon ender statistical evidence), it does not onstitute an indictment of the Wisconsin ystem of equalization. Any such in- reased misplacement of the tax burden ould seem to be a wholly fortuitous esult, and not an inevitable tendency, nd in any event the basic responsibility ould rest with the original assessment, ather than with the equalization system.

Without in any way reflecting upon the xcellence of the report, it may be pos- ble to mention a few minor points of iticism. It is stated, without any quali- cation or defending explanation, that Values realized in private sales are the est measure of actual ratios" (p. 1). his is undoubtedly entirely correct as a nal conclusion, but such a dogmatic atement, without reference to the limi- tions that are so significant when in- rpreting statistical indices, is likely to icense the critics of the use of sale alues. A second point is the use of third oment indices in connection with the easurement of the asymmetry of the dis- ibution of assessments. First moment easures are to be preferred in this con- ection in that they minimize the signifi- ance of isolated, erratic items in the dis- ibution. Finally, it may be noted that Visconsin now has only twenty-two as- ssors of income, and not forty, as is ated on page 2.

RICHARD W. NELSON,
University of Iowa.

ie Holzversorgung Deutschlands. (The Wood Supply of Germany.) By Dr. Karl Rosemann. *Kommissionsverlag Robert Kleinert, Quakenbrück i. Hannover. 1931. 74 pages.*

In this booklet Dr. Rosemann presents a compact and yet comprehensive way the intricate problem of how the wood consumption of the German nation is provided for. In the following are pointed out some of the most interesting facts reported by the author.

While the per capita wood consumption in Germany only trebled during the last century, the per capita consumption of wood's chief substitutes increased much more. Thus the consumption of coal rose from 5.8 kg. in 1835 to 276.5 kg. in 1913, and iron went from 15 kg. to 2,300 kg. per capita. The total per capita wood consumption remained remarkably stable in the last 30 years, changing from 36.0 cubic feet in 1900 to 35.3 cubic feet in 1927. The forest area, which rose from 34.2 million acres, or 0.765 acres per capita, in 1878 to 35.15 million acres, or 0.55 acres per capita in 1913 with a corresponding decrease in agricultural land, was reduced to 31.2 million acres, or 0.494 acres per capita, after the Great War, due to the separation from Germany of Alsace-Lorraine, Posen, and West Prussia. The production per acre, which was brought from 50.4 cubic feet (34.3 cubic feet per capita) in 1900 to 58.8 cubic feet (31.8 cubic feet per capita) in 1913 through intensive management, sank through the loss of those territories to 56.0 cubic feet (28.0 cubic feet per capita) in 1927. These figures show the steady aggravation of the general forest situation. Since 1865 Germany has been a wood importing country. The importation rose from 14 per cent of the total consumption in 1900 to 17 per cent in 1913 and to 21 per cent in 1927. The total wood consumption rose from 2,040 million cubic feet in 1900 to 2,480 million cubic feet in 1913 and sank again to 2,210 million cubic feet in 1927. The present consumption is divided in the following classifications:

1. 880 million cubic feet or 40 per cent fuel wood, or about 17.5 cubic feet per capita, against about 100 cubic feet in the United States.

2. 700 million cubic feet or 32 per cent sawed lumber and poles for scaffolds.

3. 280 million cubic feet or 13 per cent cellulose, wood fiber, excelsior, etc.

4. 180 million cubic feet or 8 per cent mine timbers, of which 87 per cent are used in coal mines.

5. 40 million cubic feet or 1.8 per cent railroad cross ties. In 1929 the German railroads used about 6 million ties, of which 1.5 million were of impregnated hardwood, mostly beech; 4.6 million were impregnated softwood, Scotch pine; only 17,000 were untreated hardwoods, oak; and 2.3 million were of steel. The life of treated pine ties is taken as from 20 to 25 years; for oak, 25 to 30 years; and for treated beech, over 30 years. Replacements after 6 years of service were 6 per cent for pine ties against 12.3 per cent for iron ties. The railroads therefore used 75.1 per cent wooden ties in 1928.

6. 4 million cubic feet or 0.2 per cent poles for electric lines. These poles are now all impregnated with copper sulfate or tar oil, which increases their useful life to 13.4 and 22.3 in the latter case against 7.9 years for untreated poles.

7. 50 million cubic feet or 2 per cent boxes, crates, etc.

8. 10 million cubic feet or 0.4 per cent for distillation, wood, coal, etc.

9. 13 million cubic feet or 0.6 per cent other uses.

10. 53 million cubic feet or 2 per cent export.

The tendency to employ wood for new uses and the trend to use substitutes for wood, balance each other pretty well.

The Scotch pine, the tree of the poor sandy soils of the north German plain is the most important forest tree. It covers 13.6 million acres, Norway spruce 7.5, and silver fir 0.8 million acres. The softwoods occupy 71.2 per cent and the hardwoods 28.8 per cent of the forest area.

Germany imports more than half of its pulpwood, mainly from Poland and Russia. The author's discussion of the remarkable fluctuations in the lumber trade with the different other nations insofar as it reflects upon the economic policies of these countries, is very interesting. Great quantities of telephone poles, for example, are imported from eastern countries, treated in Germany and then exported to France and Italy for reparations payments. Germany exports also much mining timber to its former mines in the Saar Basin and Lorraine from southern Germany, while its own mining district, located in the northern and eastern region, gets much of its timber from eastern neighbors. A summary table comparing the wood import from the different countries between 1925 and 1930 gives a striking picture of the instability of the general economic situation in Europe. In order to prevent the dumping of Russian wood the tariff was established on a sliding scale.

In his concluding pages the author discusses the outlook for the future, the measures taken to increase domestic wood production and the effect of the agricultural crisis in forest economy. He especially treats the advisability of afforesting submarginal rye land through state aid.

RUDOLPH STAHELIN,
University of California.

Report of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii, Honolulu. *December, 1930. Pp. 118.*

The report of the territorial forester of Hawaii for the biennium ending December 31, 1930, is one of the most refreshing American forestry documents of the times. Not only is substantial progress reported but it is evident that the work of the territorial division of forestry i

horoughly sold to the people and has heir backing. Mr. C. S. Judd, Territorial orester, reports that "activities along the arious lines . . . have increased with ealthy vigor, particularly in the extension of the forest reserve system, tree lanting in forest reserves and the successful results of such planting, and in he eradication of wild animals . . ."

The territorial division of forestry now as in addition to the territorial forester, assistant foresters, 18 rangers, one ursery man, 28 nursery agents and vorkers, 36 tree planters and one hunter, total of 89 men. This force takes care f 1,021,314 acres or one-fourth the total and area of the territory. The size of the orce has caused the department to order ts men into uniforms.

The area of the forest reserve system s now felt to be such as to insure the protection of the territory's most important watersheds. The primary purpose of he reserves is water conservation. The eserves number 63 on the six islands, Dahu having 21 and Hawaii 25, the government land included in all 63 being 667,018 acres and the private land 354,296 acres. On 3,920 acres of the private and in the reserves the management is considered such as to be detrimental to he reserves' objectives, and recommendaions have been made to acquire title to hem and thus terminate the abuses. Mr. Judd pays a gracious tribute to those managers "who have wisely devoted their private lands within forest reserve boundaries to forest purposes, in conformity with the general plan of our management of the forested watersheds of the Territory."

To those not acquainted with the wild animal problem in the territory it will be of interest to learn that goats, pigs, sheep, cattle and donkeys which have escaped domestication, have multiplied to such an extent as to seriously jeopardize, through their grazing, the integrity of the watersheds over which they roam. During the biennium 25,978 goats, 6,610 pigs, 7,672 sheep and 471 head of cattle and donkeys, a total of 40,731, were exterminated.

During the biennium "the Territory was singularly free from forest and grass fires," except for the drought periods in June and October, 1929.

From the nursery 1,315,138 trees were distributed in the two years. Thirty per cent went to farmers. Private nurseries added over 850,000 trees in the same period. Considering the size of the territory, the number of trees planted puts our planting efforts on the mainland of the United States to shame. The success of the planting is reported as exceeding expectations. Surveys made late in 1930 in plantations of several ages revealed a survival of nearly 90 per cent.

A very long list of species has been planted in 1929 and 1930. This list includes over 200 species, representing many corners of the earth. Only about 40 of these, however, were planted in numbers exceeding 1,000 plants. The leading species were paperbark (*Melaleuca leucadendron*), white ash (*Fraxinus americana*), silk oak (*Grevillea robusta*), swamp oak (*Casuarina glauca*), redwood (*Sequoia sempervirens*), ti (*Cordyline terminalis*), koa (*Acacia koa*), and bald cypress (*Taxodium mucronatum*).

EMANUEL FRITZ,
University of California.

CORRESPONDENCE

American Forestry—Fad, Subsidy or Business

Editor, Journal of Forestry,

Dear Sir:

It is evident to anyone with a knowledge of forestry, history of our public land policy and an acquaintance with the principles of economics that the article of the above title by Frank H. Lamb and appearing in the October 1931 issue of the Journal of Forestry contains many erroneous statements. The article is not based upon sound facts as one usually finds in a professional journal such as this and therefore in the interests of the uninformed reader it should not go unchallenged.

The first misstatement informs us that the early timber conservation movement was not based upon sound economics. We have only to consider the cut-over lands of the Lake States which are growing up in worthless weed species to understand that the motive that prompted this demand for government forests was based upon sound economics and that some effort was needed to utilize forests without destroying them. "Conserve" is not a synonym for "hoard" and it is misleading to use it as the author has attempted to do. It was not the intention of the sponsors of the federal forest program that timber be hoarded. Furthermore the creation of forest reserves would naturally benefit the lumber market by making the supply continuous rather than discourage lumber consumption as the author has stated.

The statement that American foresters in general believe that private forestry is impossible in this country without gov ernment aid, is without foundation. Ther are many examples of profitable privat forestry in this country. Private forestr is profitable in Europe and there is rea son to believe that the possibilities ar as favorable in America.

It is to be expected that public fores expenses might surpass the income dur ing the initial stages of developmen Especially since public forestry is in separably connected with recreation watershed protection and soil conservatio all of which are valuable resources an not necessarily detrimental to the attain ment of maximum production of lumbe products. The development of roads an forests is generally considered essentia to proper protection and administratio of forest land—therefore I disagree wit the statement that they have little use i forest development.

Foresters will generally agree with M Lamb that the primary object of forestr is to grow timber, study markets, an promote the utilization of forest product so as to secure the maximum productio at a profit from the operation, whethe the land ownership be state, national o private. Forestry schools train men es sentially to attain this object.

In one paragraph the author scores th national forests for not carrying on business that will show a profit and late states that they undersell private owner in an effort to reduce the overhead.

In criticising the Forest Service be cause of the small areas of plantation consideration should be given to the ex pense and immense equipment necessar to carry on large planting operation

atural regeneration is much to be pre-rred because of its reduced cost and cause it is the only method possible er large areas. Next to fire control, production probably receives the most nsideration on National Forests. Where e lumber operations left a few seed ees or made an attempt at fire protec-on on cut-over areas reproduction has ually been adequate to grow a new op.

It is amusing and at the same time diculous to note the attitude of Mr. amb toward the Forest Service and his treme condemnation of the conserva-on which is only hoarding to him. This titude isn't strange nor new in Ameri-n history as we have seen it fully ex-essed in the oil industry when time d again producers pumped the oil from e ground to glut markets which were adequate to pay even the initial cost production. Probably they considered to be their patriotic duty to develop natural resource which simply meant e destruction of it.

In his discussion of the important fac-rs affecting investment in private for-try the writer shows a familiarity with e subject that is lacking in his treat-ent of other phases of forestry.

His solution of the problem of the rivate timber grower centers on tax re-uction and lumber tariff. He is correct ncerning taxes, but the tariff problem not so simple as the writer seems to fer. In fact a tariff is bordering on the dge of government subsidy which Mr. amb so greatly abhors in the federal rest. It simply means that the consumer ays more for his lumber products. Con-equently he will turn more to substitutes ithout gain to either producer or con-umer.

Lumber will always be used where it an be obtained with the least cost other ctors being equal. Its value depends rgely upon its availability to markets.

If one should see Mr. Lamb's dictums in a professional journal of medicine, dentistry, education, law or the ministry, it would appear as at least startling as well as being out of place. Why should the forestry profession be guided primarily by such an axiom? Public service is usually supposed to be actuated at least partially by other motives.

No forester could publish an article in this country that so distorted principles and facts before the public as this writer has done and escape severe condemnation from the profession. Mr. Lamb can be excused for holding such views, only because of his ignorance of the United States forestry policy that he attempts to criticise. This ignorance, however, does not excuse him for attempting to influence public opinion through a professional journal. Either he should defend his statement or retract.

L. F. Smith,
New Haven, Conn.

Editor's Note: Permission to publish Mr. Lamb's article was solicited from him by the editor because it presents the views of a considerable group of men in the forest industries. In the editor's introductory leader he called attention to the lack of agreement between the views of Mr. Lamb and foresters. The editor feels that the Journal of Forestry should publish the views of people, outside or in the profession of forestry, who may be opposed to the views of foresters, to give readers an opportunity to view both sides in a controversial subject. In continuing this policy he takes full and sole responsibility, hoping only that members of the Society who oppose any views expressed will avail themselves of the opportunity offered by this department to present their criticism.

Editor, Journal of Forestry,

Dear Sir:

After reading the article *The Role of Fire in the Redwood Region* by Professor Emanuel Fritz in the October issue of the Journal, I am impelled to present some comments on the use of

fire by lumber companies based on my personal experience as Forest Engineer for the Pacific Lumber Company, an organization which has been practicing forestry for the past nine years in the region under discussion.

Perhaps 95 per cent of the fires which have occurred in late years have been man-caused, set with the intent to "burn the country over" as the "old-timers" say. Most of the older residents and many of the younger ones believe that it is better to burn over the timber and brush lands every few years. Their reasons are that, (1) fire kills off or drives out wild animals which prey upon sheep and poultry, and (2) it opens up the country for grazing and hunting, (3) it opens up logged-off lands which have become so densely covered with redwood sprouts and shrubs that it is impossible to get in after cattle. Hunters and stockmen are probably most responsible for the fires that occur in the forested area of the redwood region.

Electrical storms very rarely set fires in this region. The fires reported by Corbitt in 1923 are the only ones that have come under my own observation. In 1928 a living tree was struck by lightning but no fire was started. Lightning descended it in a spiral and removed a narrow strip of bark along its course.

Tourists and campers are seemingly well trained. They have caused very few fires in this community. "Stump-ranchers" are the cause of a few fires each year as they clear their land of the refuse left after logging. They pile brush and chunks in and around the old stumps and burn away all that will burn. After several years of such burning the stumps are reduced to such size that can be sawed off more easily or perhaps pulled. Redwood roots very rarely burn out as do the roots c
Douglas fir.

The loss in volume of old-growt
redwood, due to past fires, is probabl
considerably greater than 15 per cen
as stated by Professor Fritz. A "goos
pen" or hollow butt, causes the loss c
the most valuable portion of the tree
Goosepens are formed by fire and hear
rot. One such cavity, in a tree on Dye
ville Flat, was used by a man as livin
quarters and contained a bed, a cam
stove, and a cupboard for his supplie

When a tree with a hollow base burn
down it very often falls with a twistin
motion. This results in a splintere
trunk which burns much faster an
more completely than one that ha
fallen without breakage. Trees felle
by fire rarely have left more than on
or two logs worth salvaging in late
logging operations. Therefore, fire ca
do no good when it burns through vi
gin timber.

In the case of clearing brushy, rang
land and cut-over redwood land, a po
sible good results for the stockma
only if the burn is followed by seedin
at the right time and the proper so
and range management; otherwise th
land reverts rapidly to brush.

Newly logged lands must be burne
for the following reasons: (1) to r
move debris consisting of tops, bark
splintered logs and trees, chunks, r
jected windfalls and unmerchantab
trees broken down by logging equip
ment; (2) to provide for the maximum
of natural seeding, and greater ease c
planting (where artificial reforestatio
is practiced); (3) to reduce the fi
hazard around logging camps, loggin
operations, and for the future; (4) t
safeguard natural seedlings and plante
stock.

The old practice of burning befo
logging has been discontinued by th
Pacific Lumber Company. Logs are n

longer peeled in the woods but are brought to a central peeling plant near the mill. No burning is done in the woods until after a "side" has finished logging and all equipment has been moved to safety. The burning is now done in the spring before fire will run or in late fall after the danger of fire getting beyond control is past. Fire is controlled by trailing wherever water cannot be used. A clean burn is desirable even though it does temporarily destroy the humus and micro-organisms in the soil. There is so much debris to be removed that it requires a hot fire which must burn for several days. The first burn is rarely a thorough one but in many cases it is the only one that is permitted to burn over the area. If the area is not cleared by burning after logging, later fire-trail making is a difficult and costly job, particularly because of chunks and logs which hinder progress. Observations on some recent fires on old unburned cut-over lands proved this point conclusively. Fire-trail making through the brush, weed cover and debris was very costly; making a trail that would serve its purpose was very nearly impossible.

After a controlled slash fire the burned area grows up to fire weed, thistles, tar weed, brush and redwood sprouts. This ground cover, once established, is very effective in holding the soil in place to prevent erosion and slides and in retaining the moisture content of the soil, which, after a burn, is light and fluffy and capable of holding a large amount of water. Planted trees and those resulting from natural sowing have dense growth to compete with; however redwood, being quite tolerant, can endure the competition very nicely. Many trees surrounded by dense thickets of brush have been found to be growing satisfactorily.

The weed and grass cover which follows a fire will burn readily when dry. However, it will not burn as hot or as long as it will in brush and the logging debris. On a recent fire on a reforested area it was noted that the fire passed over this dry vegetation so fast that the entire plants were not consumed. The planted trees were only scorched and have a fair chance of survival. A good clean-up burn after logging does not prevent the grass fire hazard but it does make possible a more certain and speedy control of grass fires should they start. Therefore, as I see the fire situation in the redwoods, fire has but one service to the lumberman and that is to clean up after logging. After it has served this purpose there is no further need for fire on forest land.

As long as the present methods of logging and utilization remain in use, fire will have the above-mentioned and very necessary use in helping to prevent loss of property from uncontrolled fires. The desirability of fire prevention and control must be instilled into the minds of all. The property owners of the region must be given an understanding of the interdependence of ground cover and water supply and its importance to themselves and the community.

The tourist business is admitted to be one of the most important in the region. All possible efforts have been made by our company to keep the atmosphere clear for their benefit. As a rule, the lumber companies do their burning either before the tourist season opens or after it has closed. The smoke-filled atmosphere, when present, is due largely to accidental fires or to fires set by the minority who disregard the state fire laws and the rights and pleasures of others.

Very truly yours,
W. H. Wirt,
Forest Engineer,
Pacific Lumber Company.

Ringland Comments on Swiss Forestry

The following letter from Mr. Arthur Ringland, who is in Europe as a special agent for the U. S. Department of Agriculture and the Forest Service, gives some interesting and instructive comments and observations on the conduct of a Swiss forestry meeting and on the practice of silviculture in Switzerland. The letter was written from Langenthal, Switzerland on October 9 to Mr. F. W. Reed, Executive Secretary of the Society:

"You may be interested to know that Ward Shepard and I have just had the pleasure of attending the annual meeting and field excursion of the Swiss Society of Foresters.

"Ward met me at Geneva looking something like an Englishman on the Grand Tour and a Swiss mountaineer prepared for a hard climb. Off we started for Sion a small station in the high Alps of the upper Rhone—the place of the meeting.

"Our first introduction to the Society was in the evening — 'Rendez-vous au jardin du Restaurant de la Planta.' Some 163 members were present out of a total membership of 220. Here we were greeted most cordially by Kanton-oberförster Graf, President of the Society. With President Graf in the lead we all filed into a great wine cellar several stories below ground to enjoy a round of singing and the famous wines of the Canton of Valais. The 'rendez-vous' was still going strong when Ward and I said good-night. We had noted that the first business session was to begin at *seven in the morning!* As the only foreign guests we wanted to be on time.

"The morning session started prompty at seven (no one late!) in the Town Hall with an opening address by President Graf. He referred most graciously to our presence. Two papers were read; one on the occurence of cembran pine in the high Alps of the Canton of Valais, and one on personnel and organization which prompted vigorous discussion. A resolution was presented urging the government to take measures to curb the import of timber from Germany and Austria. The price received for home timber has dropped heavily and is giving the foresters much concern.

"After the election of new members, including the election of Professor Badoux, well known to many American foresters, as an honorary member, the meeting was adjourned and we all met at the Hotel de la Paix for the official banquet. We sat down at 11:30 A. M. and arose, more or less heavily at 2:30 P. M. A great feast and we wanted very much to send some 'wish you were here' postcards to our friends at home.

"After the dinner we left Sion in a fleet of auto buses for our first field excursion. The objective was a visit to the larch and spruce forests of Mayens de Sion and the commercial forest of Agettes. The silvicultural treatment of these forests is simple. The two principal species, composing a high forest, are the spruce (*P. excelsa*) and larch. On areas destroyed by avalanche or fire (the precipitation in this region is the lowest in Switzerland—about 15-18 inches I think), the regeneration is accomplished exclusively by the light-demanding larch. Where the stand is thinned the regeneration is a mixture of larch and spruce depending upon the degree of thinning—the spruce forming the under story. When the thinnings are light or cover must be maintained the regeneration is nearly pure spruce. An old stand of larch was shown us which has been maintained as a park although remarkable prices were offered during the War. The average age was 130 years and the volume 707 cubic meters per hectare! The largest tree had a diameter of 98 centimeters, a height of 39 meters, and a volume of 8.5 cubic meters. Merchantable timber sells

n this region for from 40 to 50 francs $8 to 10) a cubic meter. So this par-cular tree was worth, let us say, $75!

"Late in the afternoon the last demon-ration was explained but before leaving he forest we were served a 'collation fferte par la municipalité et la Bour-eoisee de Sion.' Our hosts seemed able o produce refreshment at any time and t any place.

"That evening Ward and I had a light nd quiet dinner for we observed that we vere invited to a 'soiree familiere' at the Iotel de la Paix.

"Tuesday's excursion carried us by auto o the interesting Alpine village of Lens. This village perched precariously on a teep mountain slope is in the heart of he wine district of Valais. The harvest f the grapes was underway and on every errasse groups of women were busily icking the fruit. The Mayor made a peech of welcome from the high balcony f his house and then the belles of the illage passed around trays of wine, cheese nd cakes. Nearby we inspected the for-st nursery of the Canton of Valais. This ursery is maintained as a model for the nstruction of forest guards and as a guide or the construction of small nurseries vithin their districts. The nursery seems o demonstrate the results of seed collect-ng at different altitudes. Malformation of he plants often results if seed is planted utside of its local altitude. Experimental lots also permit a comparison of seed erminated in forest soils with seed artifi-ially germinated.

"From Lens we proceeded afoot to the ommunal forest of Pahier. Until 1923 his forest had been more or less used for asturage, with, as a consequence, almost o regeneration of the spruce or larch. Grazing has been prohibited for the past ight years but in order to obtain natural egeneration 'ecroutage' or loosening of he soil is necessary where it has been rampled by the cattle. Here interesting experiments have been conducted to determine the length of time required for a given quantity of water to infiltrate the various soils. On old pasturage but closed since 1923 it required 5 hours and 6 minutes for 1,000 cubic meters of water to penetrate as compared to 1 hour and 42 minutes on soil of a plantation 8 years old; and from 17 minutes and 6 seconds to 21 minutes and 7 seconds within a plantation nearby of 20 to 25 years old!

"I plan to follow up these experiments in more detail; there may be certain phases of particular interest to Zon and Bates, Kotok and Lowdermilk, and Pearson and Cooperider of the Forest Service. Dr. Hans Bürger of the Zurich Experiment Station was on the excursion and I have accepted an invitation to join him on a field trip to the Emmenthal in the Canton of Berne. In this valley experiments have been underway for 30 years, and here it was, I understand, that Zon conceived the idea of the work at Wagon Wheel Gap.

"At noon, with the sharpest of appetites after our hike, we were served a dish peculiar to the Canton of Valais. It is something like our Welsh rarebit. Huge cheeses are partially melted over open charcoal fires and the soft portions scraped onto plates and served with boiled potatoes. Afterwards an hour's walk over the plateau of Crans brought us to Montana-Vermala where the funicular descends to the headwaters of the Rhone. From Sierre on the main railroad we journeyed a short distance to Viege where we changed trains for Zermatt at the very foot of Matterhorn. Here we remained for the night.

"The last day of the excursion started promptly at seven in the morning. The sun had not reached Zermatt but was reflected on the upper pyramid of the Matterhorn—a magnificent sight! Barry Moore climbed the famous peak a few

years ago and I sent him a souvenir post card.

"We ascended toward Riffelalp and Gornergrat through the communal forest of Zermatt—one hundred-year-old larch with a mixture of cembran pine and groups of mountain alder. The larch comes up excellently in the shade of the alder and comes in pure where there has been thinning.

"Riffelalp is about 6,700 feet in altitude and here the cembran pine is almost pure but reaches the extreme limit of any forest vegetation at 600 feet higher. Gornergrat lies in the snow-fields and glaciers at ten thousand feet affording a superb panorama dominated by the Matterhorn.

"In the rest house at Gornergrat luncheon was served and here the reunion of the Society came to a conclusion—with more compliments to the United States and ourselves. The last touch was a very moving song in which all joined from old Dr. Flurry, the dean of the Society, to the youngest member. It was the 'Le Rend des Vaches,' and we were told that it became necessary to forbid the song during the Swiss mobilization on the frontier in 1914-18 because the soldiers became so homesick many deserted.

"Shepard and I feel greatly indebted to the Swiss Society of Foresters, to President Graf and Professor Badoux for the privileges and hospitality extended to us. We feel assured that we have made many invaluable contacts as well as warm friends among the Swiss foresters.

"I shall be glad to hear from you and to know the status of conservation affairs at home. I am traveling constantly to take advantage of the open weather but it is tiring and difficult to keep up my notes. What is the outlook in Congress for forestry? I imagine none too encouraging in view of the depression. Most everywhere I go I find considerable uneasiness—'most anything might happen' seems to be the general view of the world crisis."

SOCIETY AFFAIRS

Election Results

C. M. Granger, Forest Service, Washing-
on, D. C., was elected President of the
ociety for 1932 and 1933. John D.
uthrie, Forest Service, Portland, Oregon,
as re-elected Vice-President. The follow-
g members were elected to the Council
r the four-year period ending December
1, 1935: E. L. Demmon, Southern Forest
xperiment Station, New Orleans, La.; C.
. Korstian, Duke University, Durham,
. C.; Hugo Winkenwerder, University of
Vashington, Seattle, Wash.; A. F. Hawes,
tate Forester, Hartford, Conn.

A complete report of the tellers will ap-
ear in a subsequent issue of the Journal.

Doings of the Executive Secretary

The Executive Secretary spent Novem-
er 19-21 in Chicago in attendance at
e National Conference on Land Utiliza-
on, and served on the Committee on
ummaries and Conclusions.

One whole session was devoted to dis-
ussion of forestry in relation to land use
nd papers were presented by Major R. Y.
tuart, Dr. Sam T. Dana. Dr. Raphael
on, and George D. Pratt, President of
he American Forestry Association. Of
he long list of recommendations sub-
itted by the Committee on Summaries
nd Conclusions and adopted by the Com-
erence, the following are of especial in-
erest to foresters:

"Recommendation No. 1: *Administration
f public domain.* It is recommended
hat in order to obtain conservation and
ehabilitation of the grazing ranges of the public domain that these lands be organized into public ranges to be administered by a federal agency in a manner similar to and in coördination with the national forests. Such public ranges should include lands withdrawn for minerals or for other purposes when the use of such lands for grazing is not inconsistent with the purposes of withdrawal.

"Recommendation No. 2: *Watershed protection.* It is recognized that throughout the Rocky Mountain regions and the Pacific coastal region hundreds of communities are directly dependent on nearby watersheds for their supply of water for irrigation and other purposes and in many cases this dependency interstate in scope due to the watersheds being in one state and the irrigation use in another state, and also due to the fact that the irrigation water of one state must often be stored in another state. Inasmuch as these facts can not be changed due to the geography of the region it is recommended that lands valuable for watershed protection should be administered under the supervision of the federal government.

"Recommendation No. 6: *The economic inventory of land resources and classification of soils.* The economic use of agricultural land is directly affected by topography, climate, texture and chemical properties, biological defects and location. These major factors usually determine the value of the land for production and taxation purposes. It is recommended therefore that a national inventory be made of our land resources, that soils be classified on the basis of their agricultural value, and that our land taxation system and practices be readjusted ac-

cordingly. Sufficient information as to particular soil types is now available to permit prompt and effective initial action.

"Recommendation No. 12: *Use of marginal land.* This conference has devoted careful consideration to a group of problems with which our country has never adequately coped, namely, the extensive area of land which is in use or tends to be used for purposes to which it is not physically and economically adapted or that is virtually not used at all. These lands include:

"1. Occupied farm lands which because of technological or other changes in their competitive position are no longer capable of yielding a reasonable return to farmers.

"2. Range and other lands that tend to come in or go out of farming under the stimulus of variations in the price or rainfall cycles.

"3. Extensive areas of cut-over lands that are virtually idle.

"4. A large acreage of other land in addition to the above, that tends to be pushed into use for farming when economic conditions do not justify such use.

"5. The lack of a program for such lands consistent with the public interest has resulted in consequences such as numerous farm families struggling against hopeless obstacles, which we should no longer tolerate, an increasing number of abandoned farms, a rapidly growing area of tax-delinquent land which is being resold for the same uses under which it becomes tax-delinquent, the wastage of soil resources through erosion or fire, the serious dislocation of the fiscal and institutional arrangements of units of local government through the disappearance of land from the tax rolls, a sparse and scattering population that can be supplied with adequate schools and roads only at great expense.

"This conference urges and emphatically recommends that federal and state agencies develop a coördinate program of land utilization for these extensive areas of idle or misused lands. We believe it to be a sound policy that before we undertake to retain marginal land for public ownership, every reasonable effort should be made to remove the conditions that discourage present forms of private utilization, not inconsistent with public welfare; plans for modifying such conditions should be an important part of a program for dealing with these areas. Among these conditions are the following: First, a good deal of farm or forest lands can not be utilized profitably by private individuals because of an imposed tax burden. Certainly, states and counties should not force themselves to take over such lands if a modification in tax burden would avoid this necessity. A forest tax law will frequently aid private owners to utilize lands for forests along sound lines. Second, in some forest, farming, or range and cut-over areas, the consolidation of scattered tracts into units of economic operation will facilitate profitable private utilization. Private forest utilization can be maintained in many cases by better provision of fire protection; the supply of planting stock, and for small holdings by such measures as coöperative management, cutting, hauling, and marketing.

"Recommendation No. 13: *Public retention or acquisition of land.* After every effort has been made to promote a sound type of private utilization there will remain extensive areas that are not adapted for private utilization or that for one reason or another should be under public ownership and management in order to prevent their misuse or other reasons. With the exception of small areas acquired for special requirements federal land acquisition through purchase at present is confined to the following main purposes: (Mentions (1) watershed protection, (2) timber-growing, (3) wild

e refuges, (4) national parks and onuments, and state parks and forests. *W. R.*) . . . .

"There appear to be a number of imrtant objectives in public acquisition, addition to those mentioned, some ainly of local interest and others of oader application, as follows:

"1. To withdraw from private ownership acts occupied by sparse and scattered opulation, in order to economize state ld local expenditures for public service.

"2. To provide for the permanent mainnance of local forests on which comunities are dependent or may become ependent for part-time employment, markts, supplies of raw material for local dustries, fuel, posts, and other supplies or farmers and other residents of the ommunity, local refuges for game and ther local centers of recreation.

"3. To remove from private ownership nds that are periodically brought into mporary cultivation under the stimulus f high prices or favorable yields, but re incapable of permanently profitable tilization, in order to remove the unfair ompetition of such lands to the estabished farming industry, and to prevent he serious wastes, and hardships inurred by their occupants after the temorary favorable conditions have passed.

"4. To remove from private ownership ands that can not be utilized profitably y private individuals or concerns withut serious wastage of the soil through rosion or other causes. . . . .

"The immediate task is to deal constructively with the areas that are becoming ax delinquent. . . . . Only in a few tates is existing policy in line with the equirements of a broad national land olicy. Since the interests of the state nd federal governments interpenetrate in he whole field of land acquisition, the ederal government should take the lead in bringing about a definition and coordination of objectives with the states. Plans should contemplate a unification of policies for the disposition of tax-delinquent lands, as well as for other methods of acquisition. . . . .

"Recommendation No. 14: *Soil conservation.* Steps should be taken to outline and initiate a program of soil conservation whereby damage from erosion, leaching, increasing acidity, destruction of organic matter, deterioration of soil structure, over-grazing, flooding and alkali accumulation may be reduced to a minimum."

The Committee recommends also the creation of two committees, one to be known as the National Land Use Planning Committee and to be composed of representatives from the several federal bureaus in the Departments of Agriculture and Interior interested in land use and of representatives of the Land Grant College Association, and a National Advisory and Legislative Committee on Land Use to be composed of representatives of the several leading farm and agricultural associations, forestry associations, live stock associations, and the American Railway Development Association. The first committee is supposed to assemble the facts, digest them, and point the way toward more systematic and stable land use in all its phases. The second committee is supposed to take up from that point and see that what is needed is done.

The full report of the Committee on Summaries and Conclusions has been mimeographed by the Department of Agriculture and is available for distribution in limited numbers. Any member of the Society of American Foresters desiring a copy can get one, so long as the supply lasts, by applying to this office. The complete proceedings of the Conference will be published in printed form.

Franklin W. Reed,
Executive Secretary.

Adolf Oppermann
1861-1931

Dr. Adolf Oppermann, Director of the Danish Forest Experiment Station, died in Denmark, on November 15, 1931. He became a member of the Danish Forest Experiment Station staff in 1905 and its director in 1917.

Dr. Oppermann was a corresponding member of the Society.

Shepard and Ringland Attend Swiss Forestry Society Meeting

Ward Shepard, in company with Arthur Ringland, attended the annual reunion of the Swiss Forestry Society at Sion, Valais, the latter part of September. Professor Badoux signalized the visit of the American foresters by delivering an eloquent eulogy of the splendid progress of American forestry. Shepard had an article entitled "The Handout Magnificent" in the October number of *Harper's Magazine*, analyzing the recommendations of the Public Domain Commission and pointing out that the Commission defeated its own avowed purpose of adopting a program of conservation of the public domain and that its proposals are in fact a reversion to the political philosophy and land economics of the 1880's. Shepard's present address is care of The American Express Co., Geneva, Switzerland.

Washington Section Meets

A meeting of the Washington Section was held in Washington, D. C., at the Cosmos Club, October 22, 1931. The speakers were Mr. Roy Headley of the U. S. Forest Service, who spoke on "Recent Innovations in National Forest Fire Protection"; and Mr. T. W. Norcross, who spoke on "Road Construction and Fire Protection."

Motion pictures were shown, through the courtesy of the Caterpillar Tractor Company, also a Forest Service motion picture on road work.

European Forestry Tour Proposed

The North German Lloyd is considering arranging a specially conducted tour through Europe's forests next year. No program nor date has as yet been decided upon, but the steamship company desires suggestions as to these from interested American foresters. These might be addressed to the secretary of this Society, Mr. F. W. Reed.

R. R. Fenska Resigns

R. R. Fenska has resigned from the New York State College of Forestry, Syracuse, as professor of forest engineering.

PERSONALS

Prof. Svend Heiberg, of the Department of silviculture, New York State College of Forestry, a graduate of Copenhagen and Yale Forestry Schools, has departed for a four-months forest study trip in Europe.

Under a special fellowship of the Charles Lathrop Pack Forestry Foundation, Prof. Heiberg will observe the relation of seedling trees to various soils of the Scandinavian countries and the new planting methods recently originated in Norway, also reforestation projects carried on by the Heath Society on sand dunes and abandoned farm lands in Denmark.

FORTHCOMING EVENTS

Drainage, Conservation & Flood Control Congress
February 17-19, 1932
Louisville, Ky.

5th Pacific Science Congress
May 23-June 4, 1932
Victoria and Vancouver, Canada

SECTION MEETINGS

New York Section

Annual Winter Meeting
Friday, January 29, 1932
Hearing Room, 1st Floor
State Office Bldg.
Albany, N. Y.

New England Section

Annual Winter Meeting
Boston, Mass.
February 1-2, 1932

Allegheny Section

Annual Winter Meeting
Baltimore, Md.
February 26-27, 1932

Section secretaries are welcome to use this box for announcing their meetings. Copy should be in the hands of the Editor or Executive Secretary one month before date of publication.

Announcement of Candidates for Membership

The following names of candidates for membership are referred to Junio Members, Senior Members, and Fellows for comment or protest. The list includ all nominations received since the publication of the list in the October Journa without question as to eligibility; the names have not been passed upon by th Council. Important information regarding the qualifications of any candidate, whic will enable the Council to take final action with a knowledge of essential fact should be submitted to the undersigned before February 15, 1932. Statements o different men should be submitted on different sheets. Communications relating t candidates are considered by the Council as strictly confidential.

FOR ELECTION TO GRADE OF JUNIOR MEMBER

Name and Education	*Title and Address*	*Proposed by*
Anderson, John W. Northern State Normal; U. of Mich., B. S. F., '27.	Division Forester, State Highway Dept., Cadillac, Michigan.	Ohio Valley Section
Auten, John Thompson U. of Ill., B. S., '16; Iowa State, M. S., '23, Ph. D., '29.	Silviculturist, Central States Forest Exp. Station, Ohio State Univ., Columbus, Ohio.	Ohio Valley Section
Bay, Helmuth Wymans School of the Woods, 1913-14; U. of Mont., 1916-17.	Research Associate in Forestry, Museum of Science & Industry, Chicago, Ill.	Ohio Valley Section
Beattie, R. Kent Cotner U., A. B., 1895; U. of Nebr., B. Sc., 1896, A. M., 1898.	Principal Pathologist, Bureau of Plant Industry, Washington, D. C.	Washington Section
Bell, Gilbert Y. Gettysburg College, 1 yr., scientific course; Penn State Forest School, Mont Alto, B. S. F., '27.	Assistant State Forester, Kentucky Forest Service, Frankfort, Kentucky.	Ohio Valley Section
Buck, Charles C. U. of Calif., B. S. F., '30.	Jr. Forester as Assistant Ranger, Shasta N. F., McCloud, Calif.	California Section
Casey, Abner High School.	Forest Ranger, Shenandoah N. F., Bridgewater, Virginia.	Allegheny Section
Chapman, A. G. Iowa State, B. S. F., '29; 2½ yrs. graduate work toward Ph. D. in Botany at U. of Ohio.	Assistant in Dept. of Botany, Ohio State U., Columbus, Ohio.	Ohio Valley Section
Clements, Victor A. U. of Calif., B. S. F., '26.	Junior Forester, Calif. Forest Exp. Station, Berkeley, Calif.	California Section
Cummings, William Hawke U. of Mich., B. F., '31; U. of Mich., Ohio State U. toward M. F.	Field Assistant, U. S. Bureau of Entomology, Central States Forest Exp. Station, Columbus, Ohio.	Ohio Valley Section
Davis, Joseph J. Read School of Design, '05-'08; I. C. S. Civil Engineer, '10-'13; Forestry Course, U. of C. at L. A., '27-'28-'30.	Chief Assistant Forester and Firewarden, Los Angeles County Forestry Dept., Los Angeles, Calif.	California Section
Davis, Mayhew H. U. of Mont., Forestry, one year.	Assistant Supervisor, Cleveland N. F., San Diego, Calif.	California Section
Denton, Walter B. 1 yr. Normal School, Cheney, Washington.	Forester's Assistant, Fruit Grower's Supply Company, Susanville, Calif.	California Section
Gerhart, George A. Penn State Forest School, B. S. F., '28.	Ass't Sup't of Forests, Porto Rico Forest Service, Rio Piedras, P. R.	E. A. Ziegler, J. V. Hoffman, Geo. S. Perry.
Grover, Frederick W. U. of Calif., B. S. F., '30.	Assistant Forest Ranger, Trinity N. F., Hayfork, California.	California Section
Harris, Horace Gilbert N. Y. S. College of Forestry, B. S., '31, candidate for M. S., '32.	Graduate assistant in Forest Botany, N. Y. S. College of Forestry, Syracuse, New York.	New York Section

FOR ELECTION TO GRADE OF JUNIOR MEMBER

Name and Education	*Title and Address*	*Proposed by*
kox, Dan W. J. of Wisc., '27-'29; U. of Mich., 3. S. F., '31.	220 East Linwood Avenue, Milwaukee, Wisconsin.	Ohio Valley Section
ok, Percy D. San Diego H. S., six months Business College.	Senior Forest Ranger, Lassen Forest, Susanville, Calif.	California Section
pp, Henry N. Y. S. College of Forestry, B. S., 31. Candidate for M. S., '32.	Graduate Assistant in Forest Botany, N. Y. S. College of Forestry, Syracuse, New York.	California Section
rton, Lynn A. Oregon State, B. S. F., '28.	Senior Forest Ranger, Klamath N. F., Yreka, California.	California Section
eson, Frank Avery U. of Mich., B. S. F., '31; Forstliche Hochschule, Hann., Münden, Germany.	Graduate Student, Forstliche Hochschule, Hann. Münden, Germany.	Ohio Valley Section
lker, George Hiram College, A. B., '28; U. of Mich., B. S. F., '31.	Graduate Student, School of Forestry and Conservation, U. of Michigan, Ann Arbor, Michigan.	Ohio Valley Section
ull, Josef N. Penn State, B. Sc. Biology, '15 (three yrs. forestry, fourth yr. biology); Ohio State, M. Sc. Entomology, '24.	Senior Research Entomologist, Forest Research Institute, Mont Alto, Pa.	Allegheny Section
lie, H. R. 2 yrs. Elec. Eng., Mass. Inst. Technology. Economics, Theory, Principles, Conservation, Corporate Finance, Psychology, Educational and Social, leading to degree.	In Charge of Visual Education, U. S. Forest Service, Washington, D. C.	Washington Section
hotsky, Koloman Forest Engineering Dept., Technical Univ., Prague, F. E., '24-'28; U. of Mich.	Junior Instructor, School of Forestry and Conservation, U. of Michigan, Ann Arbor, Michigan.	Ohio Valley Section
ndh, Axel G. Oregon State, B. S. F., '31.	Junior Forester, U. S. Forest Service, Eugene, Oregon.	North Pacific Section
cNitt, Howard H. N. Y. State College of Forestry, B. S., '30.	Forest Assistant, Delaware & Hudson R. R. Corp., 903 Delaware Bldg., Albany, New York.	New York Section
eier, John Louis, Jr. U. of Mich., B. S. F., '31.	Graduate Student, U. of Michigan, School of Forestry, Ann Arbor, Mich.	Ohio Valley Section
errill, Harry R. 28 units in Ed., Agricultural and Forestry subjects.	Asst. Forester, Los Angeles County, Pacoima, California.	California Section
ichols, F. W. Penn State, B. S. F., '27.	General Field Man, Kentucky State Forest Service, Frankfort, Ky.	Ohio Valley Section
'Neil, Russel Hugh Mich. State, B. S., '23.	Asst. Forester, Consumers Power Co., Jackson, Michigan.	Ohio Valley Section
oemer, Alban U. of Mont., B. S. F., '27.	Graduate Student, U. of Mich., School of Forestry and Conservation, Ann Arbor, Mich.	Ohio Valley Section
nkela, William E. U. of Wash., B. S. F., '28.	Assistant to Resident Highway Engineer, Ilwaco, Washington.	North Pacific Section
mith, Lawrence W. Penn State, B. S. F., '19. (For Reinstatement. Junior Member '23—Resigned '24.)	Consulting Representative, Southern Cypress Mfg.'s Ass'n, Cleveland, Ohio.	Ohio Valley Section
earns, Joseph Langdon, Jr. Penn State. B. S. F., '29.	Dry Kiln Operator, W. M. Ritter Lbr. Co., Glen Hedrick, West Va.	Allegheny Section
ruble, H. P. U. of Calif., B. S. F., '27.	Junior Forester, Stanislaus N. F., Sonora, Calif.	California Section
iiter, S. D. 8th grade	District Forester, Kentucky State Forest Service, Pineville, Ky.	Ohio Valley Section

FOR ELECTION TO GRADE OF JUNIOR MEMBER

Name and Education	Title and Address	Proposed by
Taylor, Geo. R. Short course, Forestry, U. C. L. A., '28-'29-'30.	Supervising Asst. of Field Divisions, Los Angeles County Forestry Dept., West Los Angeles, Calif.	California Section
Weddell, Donald J. Mich. State, B. S. F., '28.	Kellogg Fellow in Forestry, Michigan State College, East Lansing, Mich.	Ohio Valley Section
Wetmore, F. W. Knox College, B. S., 1900.	Forester, The Real Estate Company of Mexico, Mexico City, D. F.	Ohio Valley Section
Wiggin, Gilbert H. U. of Minn., B. S., '13. (For Reinstatement—Junior '21.)	Forester, Agricultural Exp. Station, Univ. of Kentucky, Quicksand, Ky.	Ohio Valley Section
Winters, Donald W. U. of Mich., B. S. F., '29.	Assistant to Prof. Ramsdell, School of Forestry and Conservation, U. of Michigan, Ann Arbor, Michigan.	Ohio Valley Section
Zimmerman, A. H. Penn State, B. S. F., '29.	Assistant Forester, Penn State Forest Service, Stroudsburg, Pa.	Allegheny Section

FOR ELECTION TO GRADE OF SENIOR MEMBER

Name and Education	Title and Address	Proposed by
Berg, Birger U. of Oslo, A. B., '20 Agric. College of Norway, M. S. F., '26; U. of Mich., 2 yrs. post graduate work. (Junior Member, 1929.)	Junior Instructor, School of Forestry, University of Michigan, Ann Arbor, Mich.	Ohio Valley Section
Den Uyl, Daniel Mich. State, '22; Cornell U., '26. (Junior Member, 1926.)	Instructor, College of Forestry, Purdue University, Lafayette, Ind.	Ohio Valley Section
Geltz, Chas. G. Penn State, B. S. F., '24; U. of Calif., M. S. F., '27. (Junior Member, 1926.)	Assistant Professor of Forestry, Purdue University, Lafayette, Ind.	Ohio Valley Section
Hall, Ralph C. N. Y. State, B. S. F., '25; Harvard U., M. F., '27; U. of Mich., Ph. D., '31; U. of Minn., '29-'30—no degree (Junior Member, 1926.)	Assistant Entomologist, Central States Forest Experiment Station, Columbus, Ohio.	Ohio Valley Section
Locke, Stanley S. U. of Mich., B. S. F., '23. (Junior Member, 1924.)	Assistant State Forester, Illinois, Springfield, Ill.	Ohio Valley Section
McKinley, T. W. Ohio State, B. Sc. F., '15. (Junior Member, 1928.)	Managing Forester, Isaac W. Bernheim Estate, Shepherdsville, Ky.	Ohio Valley Section
Pederson, Fred C. College of Forestry, Syracuse U., class of '16. (Junior Member, 1925.)	Assistant State Forester, Commission on Conservation and Development, Charlottesville, Va.	Allegheny Section
Shaw, T. E. Penn State, B. F., '21; Harvard U., M. F., '29. (Junior Member, 1923.)	Extension Forester, Purdue University, Lafayette, Indiana.	Ohio Valley Section

Elections to Membership

The following men have been elected to the grade of membership indicated.

CALIFORNIA SECTION

Senior Membership

ndling, H. L.

GULF STATES SECTION

Junior Membership

yer, Frank K.
eschke, Karl G.

Senior Membership

itchell, Homer C.

INTERMOUNTAIN SECTION

Senior Membership

eMoisy, Charles, Jr.

MINNESOTA SECTION

Junior Membership

nudson, Ray
aki, Tenho E.
ichmond, H. H.

NEW ENGLAND SECTION

Junior Membership

Atwood, Paul E.
Frost, Clyde N.

Senior Membership

Herr, C. S.

NEW YORK SECTION

Junior Membership

Macomber, Francis R.

NORTHERN ROCKY MOUNTAIN SECTION

Junior Membership

Flock, Kester D.

NORTH PACIFIC SECTION

Junior Membership

Calder, Lester E.

Senior Membership

Brandstrom, Axel J. F.

OZARK SECTION

Junior Membership

Jones, Fred J.

SOUTHEASTERN

Junior Membership

Harding, Norman R.

SOCIETY OFFICERS

Officers and Members of Council

President, C. M. Granger, Forest Service, Washington, D. C.
Vice-President, John D. Guthrie, Forest Service, Portland, Oregon.

Council

The Council consists of the above officers and the following members:

	Term expires		Term expires
Ralph S. Hosmer	Dec. 31, 1933	E. L. Demmon	Dec. 31, 1935
Clifton D. Howe	Dec. 31, 1933	A. F. Hawes	Dec. 31, 1935
Stuart B. Show	Dec. 31, 1933	C. F. Korstian	Dec. 31, 1935
Claude R. Tillotson	Dec. 31, 1933	Hugo Winkenwerder	Dec. 31, 1935

Executive Officers

F. W. Reed, *Executive Secretary* L. Audrey Warren, *Business Manager*
810 Hill Bldg., Washington, D. C.

Editor, Journal of Forestry

Emanuel Fritz, 231 Giannini Hall, Berkeley, Calif.

Section Officers

Allegheny

R. D. Forbes, Chairman, Allegheny Forest Exp. Sta., 3437 Woodland Ave., Philadelphia, Pa.
J. M. Sloan, Vice-Chairman, Anthracite Forest Protective Assoc., Hazleton, Pa.
H. F. Round, Secretary, Forester's Office, Pa. R. R. Co., Philadelphia, Pa.

Appalachian

Verne Rhoades, Chairman, P. O. Box 1346, Asheville, N. C.
C. F. Evans, Vice-Chairman, 223 Federal Bldg., Asheville, N. C.
W. K. Beichler, Secretary, 222 Federal Bldg., Asheville, N. C.

California

William G. Durbin, Chairman, U. S. Forest Service, Susanville, Calif.
Myron E. Krueger, Vice-Chairman, 231 Giannini Hall, Berkeley, Calif.
Hubert L. Person, Secretary, 332 Giannini Hall, Berkeley, Calif.

Central Rocky Mountain

Allen S. Peck, Chairman, U. S. Forest Service, Denver, Colo.
John W. Spencer, Vice-Chairman, U. S. Forest Service, Denver, Colo.
J. A. Donery, Secretary, U. S. Forest Service, Denver, Colo.

Gulf States

E. A. Ziegler, Chairman, Southern Forest Experiment Sta., New Orleans, La.
Fred B. Merrill, Vice-Chairman, State Forester, Jackson, Miss.
A. R. Spillers, Secretary, U. S. Forest Service, New Orleans, La.

Intermountain

Earl C. Sanford, Chairman, U. S. Forest Service, Ogden, Utah.
T. G. Taylor, Vice-Chairman, U. S. Forest Service, Logan, Utah.
G. W. Craddock, Jr., Acting Secretary, U. S. Forest Service, Ogden, Utah.

Minnesota

Prof. R. M. Brown, Chairman, Division of Forestry, University Farm, St. Paul, Minn.
Dr. H. L. Shirley, Secretary-Treasurer, Lake States Forest Exp. Sta., University Farm, St. Paul, Minn.

New England

Austin F. Hawes, Chairman, State Forester, Hartford, Conn.
H. J. MacAloney, Secretary, Northeastern Forest Exp. Sta., Amherst, Mass.

New York

Arthur S. Hopkins, Chairman, Conservation Dept., Albany, N. Y.
H. C. Belyea, Secretary, College of Forestry, Syracuse, N. Y.

Northern Rocky Mountain

D. S. Olson, Chairman, U. S. Forest Service, Missoula, Mont.
C. K. McHarg, Vice-Chairman, U. S. Forest Service, Coeur d'Alene, Idaho.
I. T. Haig, Secretary, N. Rocky Mt. Forest Exp. Sta., Missoula, Mont.

North Pacific

L. F. Cronemiller, Chairman, State House, Salem, Ore.
R. E. McArdle, Secretary-Treasurer, 514 Lewis Bldg., Portland, Ore.

Ohio Valley

R. F. Wilcox, Chairman, Department of Conservation, Indianapolis, Ind.
A. E. Shaw, Secretary-Treasurer, Purdue University, Lafayette, Ind.

Ozark

George R. Phillips, Chairman, Oklahoma Forest Service, Oklahoma City, Okla.
A. C. Shaw, Vice-Chairman, U. S. Forest Service, Hot Springs, Ark.
Charles A. Gillett, Secretary, Extension Service, Little Rock, Ark.

Southeastern

S. J. Hall, Chairman, 1412 Barnett Natl. Bank Bldg., Jacksonville, Fla.
E. W. Hadley, Vice-Chairman, Lake City, Fla.
W. H. Moore, Secretary-Treasurer, c/o James D. Lacey Co., Jacksonville, Fla.

Southwestern

Quincy Randles, Chairman, Forest Service, Albuquerque, N. Mex.
D. A. Shoemaker, Vice-Chairman, U. S. Forest Service, Albuquerque, N. Mex.
Stanley F. Wilson, Secretary, U. S. Forest Service, Albuquerque, N. Mex.

Washington

H. A. Smith, Chairman, U. S. Forest Service, Washington, D. C.
C. Stowell Smith, Vice-Chairman, Natl. Lumber Mfrs. Assoc., Transportation Bldg., Washington, D. C.
Alfred E. Fivaz, Secretary, Bureau Plant Industry, Washington, D. C.

Wisconsin

C. J. Telford, Chairman, Forest Products Laboratory, Madison, Wis.
M. Y. Pillow, Secretary, Forest Products Laboratory, Madison, Wis.